

## PEER LEARNING IN STATISTICS BEYOND THE UNIVERSITY CURRICULUM

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*Peer learning in statistics has been described in various contexts, including in-class collaborations and assessment that takes the form of group projects; most reports attest to its positive effects on the learning process. However, peer learning arranged by students themselves can also enhance students' learning. In this paper, we describe a research project investigating peer learning "beyond the curriculum" in university statistics classes. The parameters of the project were derived from a similar study in the discipline of music. The project was carried out as an action research collaboration between students in a first-year statistics class, university lecturers of statistics and a music academic. Students were aware of the academic and social benefits of forming study groups to support each other's statistics learning, and they gave clear advice to future students in the form of a short video clip that they constructed based on their research discussions.*

### INTRODUCTION

Peer learning, collaborative learning, cooperative learning, personal learning environment and personal learning network are terms (amongst many) that indicate that learning is not a solitary activity but one that happens within a social space. Traditionally, that space is the classroom, where a teacher has most of the control. Contemporary pedagogy places more emphasis on how students learn from each other and the extra quality that such cooperative learning provides. In response, teachers have re-thought the classroom as a social learning space that can focus on group activity as well as peer assessment (Boud, Cohen & Sampson, 1999). The learning management systems used by most universities have provided an extra, off-campus, site for student interactions beyond the classroom. These spaces are, however, still very much under the control of teachers. Our aim in this paper is to examine collaborative learning in statistics outside the standard class and lecture rooms or their electronic extensions. Such learning is described by Havnes (2008) as peer learning "beyond the curriculum" (his study is in the discipline of philosophy rather than statistics).

Reise, Samara and Lillejord (2012) suggest that peer learning can have positive effects on student achievement, can reduce teacher workload, and can promote employability skills. Boud and Lee (2005) indicate that peer learning, in research environments, can be seen as a form of distributed learning where each student can see him/herself both as the centre of the learning action and a supporter of the action for others. They emphasise the idea that peer learning situations contribute to a "community of practice" (Wenger, 1998) that forms the foundation for the learning activity. The self-directed nature of research environments may account for the community that develops amongst students, but perhaps it is the peer learning that creates the community. Their students also described a strong affinity to their identity as research students.

In the context of statistics education, the usual pedagogical approach is to provide students with a graded sequence of units of study in various aspects of the discipline. Such a sequence would usually start with an introductory statistics course, and for the majority of students this will be the only statistics course they take, generally not because of a particular interest in the discipline but because it is a required component of their major studies. Formal peer-to-peer interaction usually plays some role in such courses, most often in the form of group assignments set for assessment by a lecturer, or group discussion in a tutorial mediated by a tutor. Most reports in the statistics education literature give evidence of its positive effects on the process of learning statistics (e.g., Roseth, Garfield & Ben-Zvi, 2008; Sisto & Petocz, 2012). However, there is little information on peer learning in statistics in contexts arranged by the students themselves.

In a prior study, Reid and Duke (in press) noted that musical identity for music students was enhanced through out-of-class peer activity. In that study, the coffee shop conversations,

between rehearsal breaks, and informal music making contributed positively to students' musical identity and that ideas gleaned informally made a huge impact on individual performance practices. This phenomenon was noted by Havnes (2008). He recognised that the "spheres of instruction and didactics [are] an emerging interest in issues such as workplace learning, lifelong learning, learning communities, teams and peer learning". Taking this perspective, we wonder how informal peer learning in statistics may be manifest. As with Havnes' work, our study is built on a series of narratives that illuminate the complexity of learning environments, including the interactions that occur between students during extra- and non-curricular activity. In some senses, simply being near each other makes a difference to how people learn from each other. In our study, "beyond the curriculum" also includes contemporary forms of social interactions using electronic technologies.

Mobile technologies allow different forms of just-in-time learning to occur as people make use of the technology to suit specific social situations. Dabbagh and Kitsantas (2012) suggest that this could be called a "personal learning environment" (p.3). Such personal learning environments are beyond the control of an institution, usually don't use university mandated technologies, allow for wide-ranging exploration of material and provide flexible environments. They are self-directed spaces where students have the autonomy to choose learning collaborators, topics and methods of working, and preferred learning outcomes. The notion of "personal learning network" (Warlick, 2009) adds an emphasis on social learning and connectivism, with material accessible via mobile devices, bridging the gap between analog and digital, between physical and online communication.

These approaches all seem to work well for learners, so it is tempting to try to incorporate them into a pedagogical approach to statistics, and maybe utilise some aspects in formal classes. However, this is a challenge for statistics educators, not least because they may not be aware of how students learn statistics with and from each other when they are not participating in their classes. The earlier investigation of peer learning in music (Reid & Duke, in press) provided suggestions for a possible research approach. A collaboration between academics as researchers of pedagogical approaches, students as researchers of their own learning practice, and the more traditional students as research participants seemed to be an appropriate methodological approach to investigate the problem. The project encouraged students as researchers to make their own plans to investigate each other's learning through an exploration of what peer learning meant to them. The research analysis of the results of these deliberations is now being carried out by student researchers as well as their older peers – the members of the academic research team.

## THE RESEARCH PROJECT

For an investigation of peer learning in statistics "beyond the curriculum", it seemed essential to include students as members of the research team. We advertised for "student research leaders" and focus group participants in a range of statistics lectures and selected a number of research leaders. Our plan was for one research group at each year level – first, second and third – and on the basis of previous experience in the music peer learning project we appointed two leaders for each group. Due to greater interest, we formed two research groups at the first-year level from the members of an introductory statistics unit for students of psychology. These were indeed the two groups that completed the project, and were responsible for the outcomes reported here.

The second-year group, members of a class studying applied statistics, produced only partial outcomes, used to corroborate the results from the introductory statistics class. The third-year group did not get beyond an initial meeting, due to other study and work commitments. We are currently continuing investigations with students in a final-year statistical consulting class.

The student research leaders were briefed by the academic team members about the aims and approaches of the project. They were asked to arrange two or three semi-structured focus groups with volunteers from their classes (we had a list of e-mails from interested students) to discuss various aspects of peer learning. The initial questions posed were:

- How would you typically learn statistics in an individual study session?
- What about a group study session in class (lecture or tutorial)?
- How would you typically study statistics with a group of friends from the same class?
- Are your ways of learning different from each other's?
- How would you explain to others your approach to learning statistics?

- What would you say about your statistics learning if you were with a group of friends who were not studying statistics?

An unstructured discussion followed, notes were taken by one of the student leaders and the recordings of the sessions were transcribed. We asked the student research leaders to crystallise the discussions into a short video, one for each group, that would be appropriate and useful to show to future cohorts of students. Each research group planned out and recorded their own video. Focus group participants were invited to act in these videos, and several of them did so. A final meeting was attended by one student leader from each of the groups as well as two academics; this meeting was also run as a focus group led by one of the academics. The artefacts of the project – the recordings, transcripts and video clips – formed the raw material for the subsequent analysis by the project team, including the student research leaders.

The research was approved by Macquarie University's ethics committee, and all participants were aware of the details before they consented to be research leaders, focus group members or actors in the video clips. They are acknowledged by name as actors in the videos (see [http://youtu.be/N\\_KgRcov2kc](http://youtu.be/N_KgRcov2kc) and <http://youtu.be/xfjG2MMO91g>) and as authors of this paper.

Our research methodology combined the ideas of action research and thematic analysis. The methodological approach was essentially a form of action research (McNiff & Whitehead, 2002), using the experience of participants in a learning and teaching process to find practical solutions to a pedagogical problem. The distinctions between learner and teacher, subject and researcher, are blurred in a way that is appropriate for an investigation of peer learning, particularly peer learning in contexts that are not situated in lectures and tutorials. Our analytic method was to read independently and iteratively through the transcripts, and review the video clips, in search of the important themes. Such "thematic analysis" is a fundamental form of qualitative analysis (Boyatzis, 1998). It aims to identify common ideas from the shared emphases and concerns put forward by participants, and to use these common ideas to further investigate each text.

#### PEER-LEARNING THEMES

The main themes that we identified are presented in this section, illustrated by quotes from the participants – student leaders and focus group members. Themes identified by different members of our research team, including themes illustrated in the video clips, were discussed and combined into a single list. Together, they illustrate peer learning in statistics beyond the curriculum from the viewpoint of the participants in a first-year course in statistics for psychology.

##### *Peer Learning as One Form of Support*

Peer learning was identified as one form of support for statistics learning in a diverse range of sources of support that includes the lecturer and tutors, the prepared lecture notes, textbook and online materials, formal "peer assisted learning" classes, partners who had knowledge of statistics, and private tutoring both individual and group. The discussions highlighted the diversity of support available to students in this course, and the fact that participants seemed happy to utilise several of them in their learning.

- *I think [support from tutors and from peers] definitely complement each other, because there's a real difference in being told something and being taught something and two people not really knowing but then finding out the answer together. I think you really remember better and understand things better when you didn't know a problem and then you work it out.*
- *I don't actually have a study group, but when we have the practicals, like the one we just had, me and two other friends will just go direct together.*
- *I'm quite fortunate. My boyfriend is..., loves doing assignments. So I will actually do some of my work and then tell him about what I'm doing and he's..., he did economics at university.*

Peer learning allows members of the group to combine their strengths and expertise in order to face the problems of navigating sometimes complex and confusing material.

- *I study with another two that I've met through the course and so we get together on weekends and go over stuff and look at the quizzes and the answers and everything and just try to..., but it's worked really, really well for me, because they always know..., I know something that they don't and they know something that I don't. It's really great. It's really been helpful.*

Some participants said that they preferred to start the work on their own and only get together with their peer learning group after this initial effort.

- *I find it much easier to study by myself, because I get far too easily distracted when people talk to me. So I might, I really have to, yeah, work by myself, but then we'll ask questions.*

Nevertheless, the feeling from the group was that self-arranged peer learning, most often described as “study groups”, was the single most important component for success in the course.

- *You know with this, one of the most important things is the best thing has been just having someone you can call up or email and say, I don't know what on earth I'm doing.*

### *Benefits of Peer Learning*

Most participants in this servicing statistics course don't have much background in numeracy, let alone any further mathematics, and the general feeling was that they were doing the statistics course only because it was a compulsory part of their psychology course.

- *I think it's probably because [statistics] is not a subject people are really wanting to do. I'm sure there are people who actually genuinely enjoy it and are doing it for their own reasons. But yeah, I think because it's a subject we're all doing as a pre-requisite, it's not something we're very excited about.*

Many comments described the statistics course as challenging, particularly due to the constant presentation of information about various aspects of statistics.

- *But with this unit I'm so glad I've got this study group, because I feel that it's just a lot of information coming in. There is not a lot of discussion or anything. You don't really get a lot of answers. You don't clear up doubts very much. It's just every week more information, more information, more information.*
- *But with other units it hasn't bothered me too much. There's a lot of discussion. There's more time to free up..., to clear up your doubts and everything. But this is just so much information every week, especially like, I've never seen stats, I've never seen [it before].*
- *But when you're there [at lectures], for me, it just gets overload at some stage. Like, I'm getting it, getting it, getting it, and then I just go, oh, my God. Then there's something new, something else, something else, and like, oh, too much, too much.*

The regular quizzes and assignments provide plenty of material for group discussion and learning, and indeed, students feel that their study group provides a good format for tackling the assessment.

- *Yeah, and we focus on the, yeah, the quizzes a lot, because the answers from that are sort of, we think are pretty fundamental. So if we can understand that well, that's going to help us in the exam and further down the track. Two of us are going on to do the [second statistics course].*

The peer learning group assists students to counter their negative feelings about the subject of statistics, and provides a balance to the usual focus of university courses on individual work as opposed to group work. Participants reported benefits from the process of discussing and sharing ideas with their peers and contrasted this with the experience of others who hadn't participated.

- *I did have a conversation with somebody who hadn't been going to classes and they sat next to me and asked me questions on this stuff, and I was like, this is basic stuff, and they just hadn't really been going to most of anything, so I think that's kind of like the whole..., once you reach the end of the semester and you realise that you just missed out on all the peer learning and stuff, all the time you could have been doing this!*

### *Method of Working with Peer Learning*

There were interesting descriptions of how students identified potential group members and how they set up their study groups. Their approaches included attending the first few tutorials and actively looking for likely people, in some cases people who shared their characteristics (such as being mature-aged students). Others reported eavesdropping on other members of the class to check whether they would be compatible members.

- *I think statistics is something you have a lot of questions for, so you're all sitting there at the computer, say to the next person, “how do you do this?” and then everybody sits next to each other, just start with that.*
- *Being a mature-age student it helps as well, because as soon as you walk into the first tutorial or prac [practical class] you look around and go, okay, there's one [likely partner].*

Study groups often utilised the free time between lectures that they had in common. They arranged regular meetings, and they reported a strong incentive to come to these meetings well prepared, ready to ask and answer questions.

- *With our study group we don't turn up just not knowing anything. We all want to help each other, so the idea is to go through it all, learn as much as you can, so we can actually contribute in the study group.*

*So I do as much as I can, I understand it as best as I can, before I go and meet up with these other two, so when we turn up we can just discuss those couple of things and help each other with it, which really helps so much. I wouldn't like to be doing this without the study group. It's really, really good.*

Groups often used social media, such as a Facebook page, to post questions, suggestions and comments within their group. They were very comfortable using technology for such academic reasons, rather than asking lecturers or tutors. They didn't make a big fuss about the technology, but just used whatever was available and useful; this is also shown clearly in the video clips.

- *What I have done in our study group, is that they just added their ongoing message, if they had a question, they'd just post it because they're a group of specific people, rather than going to the lecturer.*

The focus group transcripts clearly show the approach taken by students as they discuss specific problems in statistics and particular ways of learning in statistics. At one level, the focus group is also a peer learning group for statistics. This is illustrated in a comment from one of the student leaders on the process of carrying out the focus groups:

- *I think the main thing that I found out was like how important peer learning is. For me personally, I usually suffer in silence a little bit more. When I'm talking to other students, it seems like everybody does the same thing and they talk to each other and are able to realise that everybody is in the same boat and not feel like they're not getting, that they're the only one that's having a hard time with the class. So just seeing how other students go about that is a good experience.*

## DISCUSSION AND CONCLUSION

The message from the focus groups is that many students have arranged peer learning groups, or "study groups", and have made a strong commitment to these groups and to the success of their studies in statistics. They talk in detail about the individual and joint struggle to understand the lecture material and turn that understanding into successful completion of the assessment tasks. The formal lectures and tutorials play a smaller part in their overall learning; the lectures can be overwhelming in terms of material, and the tutorials are less useful, sometimes because they include other students who have not made a similar commitment to their learning.

However, the student leaders and participants in this research are volunteers. They are likely to represent those who are most organised and committed, and indeed they do talk at times about some other students who are not working at this level. Further, the situation regarding peer learning may be different in diverse statistics classes, in different universities, and in other countries. The evidence presented here is specific to this introductory statistics course for students of psychology at one Australian university. The themes identified from the students' discussions could to some extent apply to introductory courses in other disciplines, or even other courses in general. However, the nature of the first statistics course for students of psychology, particularly the heavy information content and the lack of understanding of the future professional use of statistics, seem to highlight the need for such peer learning.

Havnes (2008) reported on peer-mediated learning in a course in philosophy of science and concluded that students' problems seemed to be less with the material that they were studying and more with the broader concerns of their work and their interactions: "*the real problem is being a student*" (p.202). The students in this statistics course reported a different experience with the main focus on trying to understand the statistical material itself. However, they did talk about the problems of making the transition from school to tertiary learning, from a structured and supported learning environment to one where they have to arrange their own learning support.

Students' interactions with peers who had already completed this statistics course are of interest. These older students focused on the "ritual" aspects of the introductory statistics course (Reid et al., 2012, p.26) – the fact that the subject was difficult but necessary for progression in their studies even though they were unsure about the future role of statistics in their learning and their profession. This suggests that course designers and lecturers could focus more on the use of statistics in the professional life of a psychologist; for instance, statistical examples set in a real psychological context, case studies showing the use of statistics in psychology, interviews with professional psychologists discussing the role of statistics. Such an approach could also help to counter the perception that the course comprised "*every week more information, more information, more information*".

Participants in the focus group interviews considered the role of lecturers in peer learning. They were aware of the contrast between their self-organised study groups and the learning

organised by their lecturers and tutors, and they saw a benefit in both aspects. Though they realised that their study groups were their own responsibility, they suggested various ways in which their lecturers and tutors could assist the process of forming and keeping study groups. The most important of these were providing space in early classes, particularly tutorials, for students to meet each other, and setting small but regular assessment tasks early on, to provide an incentive for group work from the beginning of the course. A related role for tutors is to encourage and help those students who are having trouble forming or joining a group, whether from shyness, (initial) disinterest or lack of awareness of its importance.

The most important message from the research is the critical role of “peer learning beyond the curriculum”. For some participants this represented the key to success, as shown in their own words, and in the video clips that they prepared:

- *I mean, if there was no one that, if you didn't know anyone and you didn't have anyone to ask, I don't know what you'd do. If I didn't have that, if I was just by myself trying to do it, it would be..., I think I'd give up the course. I don't think I'd try.*
- *Well, I've actually found statistics is the one subject that I've made the most friends in ... because you need to!*

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