STATISTICS POSTER COMPETITIONS: AN OPPORTUNITY TO CONNECT ACADEMICS AND TEACHERS

PETER K. DUNN
University of the Sunshine Coast
pdunn2@usc.edu.au

ALICE RICHARDSON
Australian National University
alice.richardson@anu.edu.au

THEODOSIA PRODROMOU
University of New England
theodosia.prodromou@une.edu.au

TARYN AXELSEN
University of the Southern Queensland
taryn.axelsen@usq.edu.au

ABSTRACT

The Australian Statistics Competition (ASC) was a national statistics poster competition that ran from 2006 to 2016. One of the aims of the ASC was to create connections between academics and teachers. In this paper, we report a study that investigated the experience of the organisers of this competition. We administered a written survey and conducted semi-structured interviews with the organisers by a semi-structured protocol, with the aim of exploring the experience of the ASC organisers (the academics) in relation to connecting with teachers. We found geographical, intrinsic, organisational and personnel barriers to continuing connections between academics and teachers. We provide a list of recommendations for those involved in, or planning on starting, a similar competition.

Keywords: *Statistics education research; Collaborations; Schools; Statistical literacy*

1. INTRODUCTION

Promoting and enhancing statistical literacy in schools is important for many stakeholders, including tertiary educational institutions (universities). Students' and adults' ability to make informed decisions by collecting, organising, describing and interpreting data is a skill considered highly relevant in order to make evidence-based decision making (MacFeely, Campos, & Helenius, 2017).

Statistical poster competitions are a relatively new concept (compared to mathematics multiple-choice exam competitions, which began in Australia in the 1970s), but their popularity has increased as educators see the value in encouraging statistical literacy among school-aged students and creating an environment where students can answer real questions using real data (Quinn, 2002; Sanchez et al., 2011). The project-based learning activity of a statistical poster competition requires students to create an informative poster presentation (akin to a conference poster) that addresses a freely-chosen question that stems from an area of interest to the students and is investigated by utilising the selection of the question, collection, presentation and interpretation of data.

These competitions

- are generally beneficial (Brady, 2002);
- are popular for motivating and advancing statistical literacy for students and teachers (Moreno & Schollenberger, 1998);
- develop students' critical thinking, investigation, collaboration, communication, reporting and creative skills; may promote and optimise learning (Lieberman, 2000);
- are seen as a way to connect university educators with the next generation of learners;
- and may serve to unite interested stakeholders worldwide (MacFeely, Campos, & Helenius, 2017).

Statistical poster competitions in English-speaking countries have a relatively short history; for example, the American Statistics Poster Competition began in 1990 (Moreno & Schollenberger, 1998), the Australian competition began in 1996, and the International Statistical Literacy Project (ISLP) Poster Competition was in progress by 2007. These competitions provide evidence of a growing popularity and an increasing number of submissions. In 2016/17, the ISLP competition had 37 participating countries and more country contacts for the 2017/18 competition (ISLP, n. d.). Early traces of statistics poster competitions are found in Japan during the 1950s (Gabrosek, 2006) but their influence did not spread to Western countries.

The aims of the competitions vary but common targets include increasing students' statistical literacy and confidence in statistics. The explicit aims of the ISLP Poster Competition and the American Statistics Poster Competition are quite similar with respect to the skills and competencies required:

- To improve students' abilities in describing their environment with help of statistics and in using statistics as a tool for learning about their lives on a daily basis (ISLP, n. d.).
- Improve students' statistical thinking – their quantitative literacy – by encouraging them to use data-based graphics to both interpret their data and to communicate their conclusions to others (Moreno & Schollenberger, 1998).

Typically the aims do not explicitly mention establishing connections between schools, students and universities though this may be inferred from the documents indirectly. One notable exception is the Australian implementation of the ISLP (NSPC, n. d.), explicity stating the aim:

> Build relationships between University – Schools – Teachers – Students – Professional societies (build community) […]

In this paper we explore the *Australian Statistics Competition* (ASC), which started in Australia in 1996, went national in 2006 and ran until 2016, and which aimed to tap into students' interests and to demonstrate the interdisciplinary nature of investigations. One of the unique aspects of the Australian competition was the explicit intention of making connections between academics, teachers and students. We begin by giving relevant background to the ASC, then discuss this study and the methods used, followed by a discussion of the results, and concluding remarks.

2. BACKGROUND

The *Australian Statistics Competition* (ASC) emerged from the University of Southern Queensland (USQ) in 1996 as the *Australian Statistics Competition for Schools*. The competition ran annually from 1996, under many similar names, until 2016. We refer to the competition under all of its names as the ASC for simplicity. We first describe the history and development of the competition and then discuss the targets of the competition, especially the intended extension of sustainable connections between university and schools.

2.1 DEVELOPMENT OF THE ACS

Early phase of ACS. The competition ran as a pilot in 1996 with schools in the USQ catchment area for Years 11-12, sponsored by USQ, the Statistical Society of Australia (SSAI) Queensland Branch, the Young Statisticians Section of the SSAI, and the Australasian Region of the International Biometric Society (IBS); it required teams of two to three students to submit a physical poster. The ASC was promoted only in Queensland until 2004; however, entries were accepted from throughout Australia. In 2005, the ASC was extended also to Western Australia and had 115 submissions from 272 students from 19 schools (Dunn & Fahey, 2006).

Transition to a national competition in 2006. The ASC became national in 2006 with the support of the SSAI, USQ, and the CensusAtSchools project from the Australian Bureau of Statistics (ABS), with Texas Instruments (TI) as major sponsor. The transition to a national level competition assembled interested university academics from eight institutions who became the state (for simplicity, we refer to state whenever the local designation would be state or territory) contacts for submissions from secondary schools with three divisions: Intermediate (Years 7-10); Senior (Years 11-12), Junior (below Year 7) (Dunn & Fahey, 2006).

The engagement of the Australian Mathematics Trust and electronic submissions 2008/09. In 2008, the Australian Mathematics Trust (AMT) began administering the ASC, through hosting webpages, managing registrations, advertising to schools, producing brochures, distributing participation certificates, and distributing prizes and prize certificates. The AMT introduced entry fees to support their management of the competition (which were about $20 per team till 2016). The ASC was also partially supported financially by the ABS through most of its existence.

In 2009, electronic and traditional hard-copy posters entries were accepted, and from 2011 onwards, *only* electronic submissions were accepted. Electronic entries included PowerPoint and PDF documents; while other electronic entry formats (such as videos) were also permissible, however only one alternative format was ever submitted.

The transition to the national competition of the ISLP. In 2016, the ASC was supported by nine academics from seven Australian universities, and 362 entries were received across the three divisions. In 2016, the competition ran for the last time, with the emergence of the *National Schools Poster Competition* (NSPC, n. d.), sponsored by the SSAI, which is connected with the ISLP (ISLP, n. d.). Some academics involved with the ASC are now involved with the NPSC.

2.2 THE ASC AND MAKING CONNECTIONS

This article investigates the ASC during its time as a national competition from 2006 to 2016. The focus lies on the way the ASC connected the universities to the schools and what factors influenced the partial success of the connections and which barriers hindered the shaping of sustainable connections. By 2008, the main aim of the ASC was:

- to encourage school students and their teachers to apply statistical thinking and (syllabus-appropriate) statistical methods to activities, which inspire interest and confidence in statistics.

The secondary objectives were:

- to promote interest in statistics throughout the community;
- to promote understanding of the role of statistics within the community;
- to provide further opportunities for communication and cooperation between universities and schools.

The last aim, to connect universities and schools, is the focus of this paper which explores these connections.

Since the national roll-out in 2006, the ASC used a distributed organisational model, with coordinators in most Australian states (the "organisers"), plus one central organiser responsible for liaising with the AMT providing national oversight, judging, and as a contact for the states. The main reason for this distributed system was to distribute judging responsibilities and to encourage each academic to form connections with local schools and teachers. Some states had a team of organisers rather than a single organiser.

ASC organisation was supported through a Google group with cloud facilities for storing documents such as minutes, e-mail contacts and conference calls, which were usually done once a year for planning and finalising judging. Submissions were judged by academics within each state using a short rubric with broad categories that included the categories of Planning and Data Collection (3 criteria; accounting for about 32% of the final grading), Analysis (5 criteria; 53%), and Presentation (3 criteria; 16%). Each state nominated at most two submissions from their region in each division for consideration as national prize winners. National winners were voted online by all organisers.

The ASC was a successful competition, sustaining between 100 and 200 entries through to its final year, despite the challenges of organising a national competition with organisers dispersed around Australia. All criteria for successful competitions identified by MacFeely, Campos, & Helenius (2017) were present to varying degrees. The provision of a *Teachers' Pack* available from the website developed into a key support for teachers; this package contained basic information about the competion including the rules and a description of the judging process; it also offered suggestions for project ideas and a summary of basic statistical concepts and techniques.

This paper explores the experience of the organisers of the ASC between 2006 and 2016, and specifically how the ASC enabled them to establish connections with teachers and schools. Sixteen organisers were involved over that time, with all states of Australia represented each year (except Tasmania until 2008; the Australian Capital Territory in 2007; and the Northern Territory which, apart from 2006 when it stood alone, was incorporated with Queensland). In this study, our aims are to:

(a) identify the characteristics of the competition that helped to increase collaborations between academics and schools; and
(b) investigate organiser experiences of barriers to collaboration between academics and teachers.

3. METHODS

The researchers obtained the most recently-available contact details of the 16 university academics involved with the ASC throughout its history as a national competition. Some had moved or retired, and hence some of the academics could not be contacted despite multiple attempts. The contacted organisers were directed to a questionnaire, hosted by SurveyMonkey (Appendix A). The survey was designed to preserve anonymity, though with the small target population such issues cannot really be ensured. Nonetheless, identifying information (such as age and sex) were not collected for this reason. Interview transcripts were anonymised by a research assistant (RA) before being presented to the research team, though some possible identifiing information may have remained. Some academics acted as an organiser while working at more than one university; they were instructed to answer for the university where they most recently worked while involved with the ASC where this was relevant. After redirection to a different site to preserve anonymity, respondents were invited to participate in a short phone interview. These semi-structured interviews (about 20 minutes each) were facilitated by a research assistant neither connected with the ASC nor with this study. The purpose of the interview (see Appendix B for the frame) was to explore issues that emerged from the questionnaire. These interviews were recorded after obtaining permission, then transcribed, and only then presented to the research team with identifying information removed.

4. RESULTS

In this section, we discuss basic demographic characteristics of the sample, followed by a description of the collaborations that arose from the ASC. Features of the competition that contributed to successful coollaborations and barriers to establishing such collaborations are also detailed. Administrative features of the competition that evolved over time and may impact upon collaborations are discussed in the final section. In what follows, extracts from the interview with, say, Subject number 9 as identified as I9; comments made in the questionnaire are signified by an S.

4.1 DEMOGRAPHICS

Of the 16 potential respondents, twelve (75% of the target population) responded to the questionnaire and nine (56.3% of the target population; 75% of respondents) agreed to be interviewed. Because of the small numbers, formal inferential statistical analyses were deemed inappropriate. Eight respondents were academics in mathematics or statistics, three in mathematics or statistics education, and one in another area. Eight organisers were involved for more than five years, and one for only one year. Eight organisers were involved both before and after the changes in 2008 (entry fees introduced) and 2009 (transition to electronic entries).

4.2 DESCRIBING COLLABORATIONS

Despite being an aim, connecting organisers and the schools was never explicitly encouraged or discouraged or identified as a requirement of being an organiser with the ASC. In any case, clearly a school-based competition provided opportunities for such connections. It is the nature of these connections that are now explored.

The most common connection (Table 1) was through organisers presenting awards or prizes (7, or 58%), while three respondents indicated no engagement with schools at all. Three respondents reported that they maintained a working relationship with teachers from schools because of their involvement with the ASC, and four (33%) respondents reported that their involvement with the ASC *increased* their engagement with schools compared to their previous experience. One academic reported enhanced collaborations with other university colleagues as a result of involvement with the ASC. One successful connection not listed was reported in the interview (I9 below). Some organisers continued existing connections with schools after becoming involved with the ASC (I9, S) but I9 was clear about its relative insignificance compared to other activities.

Table 1. Ways in which academics collaborated with teachers/schools[1] (Question 11: n =12)

Collaboration type	*Number*	*%*
Held an award ceremony, prize giving	7	58
Maintained working relationships with teachers/schools because of the ASC	3	25
Conducted information sessions for students	1	8
Maintained a professional relationship with teachers because of the ASC	1	8
Conducted professional development sessions for teachers	1	8
No engagement with the school	3	25

[1] Respondents could select all types that applied

I9 The very first year I did the poster competition, I put all the posters up at the teaching sessions [i.e. professional development sessions] that my university put on for these high school teachers, so the teachers could see it. That was the best advertisement.
S I was already involved [with schools ...] I talked about ASC when I became involved […]
I9 The fact that I was involved in the poster comp was pretty insignificant compared to other things that were going on […]

The mean number of schools with whom the organisers developed a *continuing* relationship was 1.1, and five reported zero; the median number of schools was 1. The relationships were usually formed with *teachers*, who were often mobile, rather than *schools*, and some teachers entered from various schools in which the teachers were placed. This meant that sometimes sustained collaborations were difficult (I9). One organiser (I7) made deliberate, and successful, efforts to sustain connections with teachers.

I9 There were one or two teachers who, in the early days, were entering posters and I'd go out and present prizes […] And of course, those teachers would move on and then they'd disappear.
I7 I started going to the mathematics association annual conferences, discussed with teachers about the competition, explained to teachers about the aim of the competition and got different schools involved in the competition […] I visited schools, I did presentations and I still have these relationships with those schools.

4.3 FEATURES CONTRIBUTING TO SUCCESSFUL CONNECTIONS

In this section, we report on questions where organisers were asked about their perception of which features of the ASC contributed to making the competition successful, including meeting the aim of making connections. Interestingly, despite being the most common type of connection (Table 1), school visits rated the least helpful feature (mean 2.2; see Table 2). The most valued engagements were the website (mean 3.3) and the *Teachers' Pack* (mean 3.2); both resources that allowed convenient access to information without impinging upon the academics' time.

Respondents were asked about which competition features were easy and hard in practice (Table 3). "Finding time to connect with schools" (90%) and "Finding time (for the ASC)" (75%) were the most difficult, followed by "Having sufficient institutional support" (50%). In contrast, the easiest was "Answering questions from teachers and/or students" (only 1 respondent (10%) found this hard).

Clearly, then, connections between academics and schools, while present, were not substantial, and even the most common connection (school visits) was not seen as essential. We now explore possible barriers to connections.

Table 2. Contribution of specific features of the ASC to its success[1] (*Question 9, n = 12)*

Feature	*Not at all*	*Little*	*Lot*	*Substantially*	*Median*	*Mean*
Website	0	1	6	5	3	3.3
Teachers' Pack	0	2	2	4	3	3.2
Trans-Australian team	1	1	6	4	3	3.1
National judging	1	2	4	5	3	3.1
Google group (e-mail)	0	4	1	4	3	3.0
Meetings	1	1	6	2	3	2.9
Intra-state judging	1	3	4	3	3	2.8

School visits	1	5	1	1	2	2.2

[1] Not at all = 1; Substantially = 4

Table 3. How hard or easy various ASC initiatives were perceived[1] (Question 3, n = 12)

Category of answer	*Very hard*	*Hard*	*Easy*	*Very easy*	*Median*	*Mean*
Answering questions from teachers / students	0	1	8	1	3	3.0
Connecting with colleagues	0	2	9	0	3	2.8
Administration	1	3	7	0	3	2.6
Marking intra-state	1	4	4	1	2.5	2.5
Marking national	1	5	4	1	2	2.4
Institutional support	3	1	3	1	2.5	2.3
Finding time (for the ASC)	3	5	3	1	2	2.2
Finding time to connect with schools	7	2	1	0	1	1.4

[1] Very hard = 1; Very easy = 4

4.4 BARRIERS TO COLLABORATION

Some respondents saw their involvement in the ASC as a direct impediment to connecting with schools.

I8 I […] didn't make connections with schools because that's helping them… I was worried about favouring one school over another.

When asked to identify the biggest barrier to making connections (Table 4), most indicated the academic being busy (eight as a big barrier; three as minor) and the teachers being busy (six as big; two as minor). This implies that support for the academics would be beneficial, but "Lack of university support" was not considered a barrier by five of nine respondents.

Table 4. Barriers to connecting academics and schools/teachers[1] (Question 13, n = 12)

Potential barrier	*Big barrier*	*Minor barrier*	*Not a barrier*
Organiser busy	8	3	0
Teachers busy	6	2	0
Students busy	2	5	1
University support	3	1	5
Uni/school semesters did not align	1	5	3
Timing of ASC and when students studied statistics	0	7	1

[1] Due to non-response, the sum differs for each question

Comments from the interview support busyness as a barrier.

I1 As an academic it was about the time commitment, choosing how much time to spend on volunteer activities… The competition was long-running, there wasn't much direct contact with schools, and so it was hard to see what I would get out of my involvement as an academic.

I3 Lack of time: academics weren't workloaded (sic) for this […]
I7 I wish I had more time.

In particular, the time taken to judge the entries was a barrier. However, I4 below identified finally that the time problem with judging was actually one of scalability.

I2 The judging was tedious [compared to other math competitions].
I4 Once I had 200 posters to mark, so not only could you [sic] not mark them as well as I would have liked. […]
The judging became quite onerous when the entries increased […] Some of the procedures that we had in place […] weren't scalable because we started off with a small number of entries but when it increased that didn't work so well so we had to adapt over time.

The judging was also reported as the aspect of the competition that was least enjoyable.

I1 [I least enjoyed] the last minute rush that always seems to accompany the very last stage: the national judging.
I3 The timelines on the marking [of the posters]: they were always around the busy time in the semester.
I2 The judging was tedious.

One respondent thought that it was not the time involved, but rather that almost all of the work (judging) came in a very short space of time (intensity).

I9 […] the poster competition really didn't take that much time […] I was marking hundreds of these things and I could get it done in 2 days […] some of these posters were just rubbish; when you've got a hundred you can easily dismiss at least 50 of them. It took longer for a PowerPoint to open up on a computer than it did for me to mark it.

One organiser, however, disputed that time itself was the major barrier; rather, it was that the available time was spent judging rather than connecting with schools.

I5 The thing [barrier] that comes to mind is that people didn't have enough time to do it, but that's not actually true. I think everyone who volunteered put in sufficient hours. I think the biggest barrier is just getting out to the schools and finding a way to engage with the schools which is meaningful.

Despite the time commitment presenting as a barrier, three participants (25%) reported no support from their university. Indeed, most organisers stated that they did not require or even expect any recognition from their university. This emerged in the following interview also.

I7 It would have been nice to have more support from the university and an allowance for 1 to 2 days work to focus on the competition.

Connecting with schools can also be difficult when they are geographically dispersed.

I7 It was very difficult, it required a lot of effort from me… In most of the cases I had to travel to meet them and I'm busy… to do the travelling when they're available, it was difficult. [For example,] I was driving for 2 hours to go to a school.
S Very few of the participating schools were nearby. Our region covered much of regional (state).
S I was in a regional university where access to schools was limited because of the travel.
I8 It was nice to go and present at the school but I didn't have any funding or anything so it

was me making the trip to the school […] later on, another school [in my state] won; but it was far away so it would have cost me more of an effort to get there. It would have been an expensive exercise […]. Not so much the driving, if you've got the time to do it but the cost.

Implicit in all of these comments is that organisers thought that face-to-face connections were the best, despite being difficult. This thought was made explicit by one interviewee.

I4 Emails aren't personal enough and may not go to the right person. Face-to-face is the best way I think to establish a connection, however, I was not able to go out to schools to do this.

Another barrier that emerged was the time required for students (and teachers) to produce a competition entry over a period of time, when most school-based competitions simply require students to sit a test at a given time with little input from teachers.

I1 […] competitions, which are short and sharp are more attractive to school students than one which seems to drag on for a period of months with an uncertain amount of time input from students themselves.
I7 […] schools [...] didn't take the offer because of their schedule, time pressures […] this [competition] will be extra pressure on mathematics teachers because mathematics teachers did not feel comfortable to get their students involved in the competition.

A further barrier to connecting academics and teachers through the ASC was that due to the nature of the competition, it was difficult to provide individualised feedback:

I6 A minor frustration was that it wasn't clear how to contact schools to give feedback.

Again, this is an issue of scalability that other competitions (such as the Australian Mathematics Competition) do not have, since feedback and judging occur semi-automatically. This is not (currently) possible when judging posters.

One last barrier, which was mentioned by six of the twelve respondents, was that they believed knowledge of statistics was a limitation to teachers (and hence students) becoming involved.

I1 [Some] teachers don't understand statistics very well [... they] didn't necessarily do it in their degree; so it's something that they are not necessarily good at and other research [...] shows that stats books they've used in schools have got lots of errors […] teachers don't really have a lot of confidence when it comes to using stats.
I8 […] the big barrier in our state was the lack of statistics in the curriculum.
I9 […] mathematics is being taught by maths teachers, not statisticians. So in many cases they had no training in statistics at all; they hadn't even done a subject in it at university […] these teachers just didn't know what to do; they needed training to teach it […] more importantly teachers are just not trained to teach it [statistics], so it will end up looking like mathematics.
I7 [Teachers] said it requires a lot of work, a lot of organisation of our students and we believe our students will not be able to meet the standard.

Seven of the tweleve respondents (58%) indicated that the statistical content of the curriculum was a limitation to the quality of entries. Combined, these last factors seem to suggest connections with the competition were limited because of the statistical capacity available to students (through the curriculum, textbooks and teachers' knowledge). These capacity limitations are supported by other research (SSAI 2005; Marshman, Dunn, McDougall, & Wiegand 2015; Dunn, Marshman, McDougall, & Wiegand, 2015; Dunn, Marshman, & McDougall, 2017).

4.5 COMPETITION FEATURES THAT MAY IMPACT CONNECTIONS

Some aspects of the ASC have the potential to be beneficial or detrimental to creating and sustaining connections between academics and teachers. In particular, some innovations were made to ease the judging burden, the biggest barrier as identified earlier.

Entry fees. Fees were introduced in 2008 when the AMT acquired the organisation. One motivation for involving the AMT was to free up the time of academics spent on promotion and administration, which could otherwise be spent on making connections. Respondents reported that this move made administration easier (four agree; two strongly agree); however, none reported that it made judging (the more onerous component of being involved with the ASC) any easier. Thus entry fees may have freed some time to make connections, but did not reduce the major time commitment of judging.

Electronic entries. The introduction of electronic entries was to make the competition more attractive to students, but also to make handling entries and judging easier. This was a minor success: judging was reported to be slightly easier (two disagree it was easier; three agree it was easier; three strongly agree) and administration slightly easier (two disagree; three agree; three strongly agree). However, one respondent thought the move to electronic entries impacted quality.

I9 The quality of the entries just deteriorated, the amount of info that people were presenting was dramatically lower, which in some ways made marking easier [laughs]… the statistical detail was important to me, and a lot of that disappeared when we went electronic.

5. CONCLUSION AND DISCUSSION

The ASC operated for many years, and for 10 years as a national competition, with one of its aims to promote connections between organisers (academics) and teachers/schools. This study has shown that these connections are most often one-off publicity events (such as prize giving events) rather than sustained collaborations, despite organisers seeing these one-off connections as not very helpful or crucial to the running of the competition itself.

Some barriers to collaboration emerged from the study. These barriers were: *geographical*; *intrinsic*, due to nature of the competition; due to the competition *organisation*; and due to *personnel* issues (the nature of teachers' and academics' work).

Geographical barriers. There are a *small* number of universities (and academics), located in highly populated *urban* areas, but there are *many* schools (and teachers) dispersed *throughout* each state/territory. This means that forming meaningful face-to-face collaborations was often difficult.

Intrinsic barriers. The nature of the ASC presents barriers: the time needed to produce a poster entry; the difficulty in providing feedback (which can close-the-loop on connections between academics and teachers); the amount of input into the ASC required by teachers is more than most school-based competitions; teachers may lack the confidence, knowledge or support to provide this input; and contacting teachers could be perceived as playing favourites.

Organisational barriers. These include: the time taken to judge posters, requiring a reasonable investment of work in a short space of time, and may create delays between submissions and announcement of results, and hence prize giving (the most common point of connection).

Personnel barriers. These include: the busyness of teachers and academics; and that teachers often change jobs, so it is easy to lose contact with interested teachers.

Many of these barriers impact the time availability (of academics, and of teachers), which was the most commonly-perceived barrier to creating better connections. One partial solution to solving this time barrier is to provide support to the academics to encourage connections. In contrast, universities (who require academics to "engage" with their community) offer very little, in general, tangible support to academics to create or maintain these connections. Indeed, organisers do not expect such support.

In closing, we offer these recommendations for other similar competitions, for consideration to enhance collaborations between academics and teachers.

***Organisation*.** Deliberately involve teachers in the competition organisation (Brady, 2002). We refer to two passages from the interviews.

I5 The group we had running the program […] needed more teachers on it because we were just academics.
I2 […] find who the key teachers are in your neighbourhood and get them excited about it as a starting point.

***Promotion*.** Explicitly market the competition to teachers of science and other disciplines (Richardson & Barker, 2016), not just mathematics teachers.

I8 […] the best entries we were getting had a strong science focus […] it was the science teachers who were doing a better job at having more focussed investigations and better organised presentations of the data.
I9 […] we were talking to maths teachers, who were not the right people to talk to.

***Personnel*.** Intentionally maintain contact with interested teachers, as teachers are often transient and move between schools; offer professional development (PD) to support teachers who may lack skills or confidence.

I8 I think the most important thing would be to – early on in the year – do professional development with the teachers and give them an opportunity to experience what we would have liked the students to experience and then take that back. Learn what to do by doing it yourself.

Support. Explore means for providing tangible support for academics by universities (even a few hours assistance to help with judging, or providing PD for teachers).

***Technology*.** Devise ways of allowing urban-based academics in few locations to engage with non-urban based teachers in many locations, and reducing the need for face-to-face connections (probably using technology).

***Judging and marking*.** Investigate efficient means for judging entries that are, and are perceived to be, objective; explore practical ways to close the feedback loop as a means of sustaining connections; and investigate scalability to ensure academics do not spend their limited time on marking in place of connections.

Some of these are not easy to implement, and involve changing the fundamental nature of poster competitions. The current models are successful on many fronts; however, creating and maintaining connections between academics and teachers are likely to flourish only if *deliberate* (and resourced) attempts are made to support them.

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APPENDIX A: THE ONLINE SURVEY

Q1: What type of job did you have for the majority of your involvement in the ASC?

- Academic: mathematics / statisics department ☐
- Academic: education department ☐
- Academic: mathematics / statsitics education ☐
- Academic: other ☐
- Other ☐

Q2: How long were you involved in the ASC, in any capacity?

- Less than 2 years ☐
- 2 to 5 years ☐
- 5+ years ☐

Q3: In terms of the competition organisation, please indicate the extent to which these aspects contributed to the successful organisation and running of the ASC.

	Substantially	Quite a lot	A little	Not at all	N/A
• Having a team with members from most states/territories	☐	☐	☐	☐	☐
• Phone/Skype meetings for communication	☐	☐	☐	☐	☐
• Public website (for rules, guidelines, etc)	☐	☐	☐	☐	☐
• The intrastate judging process	☐	☐	☐	☐	☐
• The national judging process	☐	☐	☐	☐	☐
• Google group: for regular (e-mail) conversation	☐	☐	☐	☐	☐
• School visits	☐	☐	☐	☐	☐
• An online Teachers' Pack	☐	☐	☐	☐	☐

Q4: In terms of the competition organisation, please indicate the extent to which these aspects were difficult or easy in terms of helping your organisation of the ASC.

	VD	RD	RE	VE	N/A
• Finding sufficient time	☐	☐	☐	☐	☐
• Connecting with colleagues from around Australia	☐	☐	☐	☐	☐
• Finding sufficient time to connect with schools	☐	☐	☐	☐	☐
• Marking (intrastate)	☐	☐	☐	☐	☐
• Marking (national)	☐	☐	☐	☐	☐
• Answering queries from school teachers and/or students	☐	☐	☐	☐	☐
• Administration	☐	☐	☐	☐	☐
• Sufficient institutional support	☐	☐	☐	☐	☐

Coding: VD Very difficult; RD Reasonably difficult; RE Reasonably easy; VE Very easy

Q5: Thinking about the ASC over the time of your involvement, to what extent do you agree or disagree with these statements?

	SD	D	A	SA	N/A
• The quality of entries was of a sufficiently high standard	☐	☐	☐	☐	☐
• The statistical knowledge of teachers was a limitation to quality of entries	☐	☐	☐	☐	☐
• The statistical context of the curriculum was a limitation to quality of entries	☐	☐	☐	☐	☐

Coding (Q5 – Q10): SD Strongly disagree; D Disagree; A Agree; SA Strongly agree

Q6: From 2008 onwards, entrants were required to pay an entry fee of around $20 per team to enter the ASC. (Previously, entry was free.) The reason was that the Australian Mathematics Trust (AMT) took over the administration of the ASC. From your perspective, how do you think this influenced the entries?

	SD	D	A	SA	N/A
• The quality of entries increased after entry fees were introduced	☐	☐	☐	☐	☐
• The number of entries increased after entry fees were introduced	☐	☐	☐	☐	☐
• The judging was easier after entry fees were introduced	☐	☐	☐	☐	☐
• The administration was easier after entry fees were introduced	☐	☐	☐	☐	☐

Q7: In 2009 to 2010, entrants could submit paper or electronic submissions. From 2011, all submissions were electronic (e.g., Powerpoint presentations, or PDFs of posters). From your perspective, how do you think the introduction of electronic entries influenced the entries?

	SD	D	A	SA	N/A
• The quality of entries increased after electronic entries were introduced	☐	☐	☐	☐	☐
• The number of entries increased after electronic entries were introduced	☐	☐	☐	☐	☐
• The judging was easier after electronic entries were introduced	☐	☐	☐	☐	☐
• The administration was easier after electronic entries were introduced	☐	☐	☐	☐	☐

Q8: Throughout the life of the ASC, prizes were awarded for winners at national and state levels. In addition, participation certificates were issued. From your perspective, what do you think the impact of having prizes had on entries?

	SD	D	A	SA	N/A
• The quality of entries was higher than it would have been otherwise because prizes were offered	☐	☐	☐	☐	☐
• The number of entries was higher than it would have been otherwise because prizes were offered	☐	☐	☐	☐	☐

Q9: As a reminder, the objectives of the competition were to encourage school students (and their teachers) to apply statistical thinking and (syllabus appropriate) statistical methods to activities which inspire interest, create curiosity and improve confidence in statistics. Please rate how helpful each of the following was to the ASC meeting its objectives.

	SD	D	A	SA	N/A
• The use of students teams/groups	☐	☐	☐	☐	☐
• The online judging	☐	☐	☐	☐	☐
• The Teachers'Pack	☐	☐	☐	☐	☐
• The online webpage	☐	☐	☐	☐	☐
• Allowing students to choose their own project	☐	☐	☐	☐	☐
• The marking rubric	☐	☐	☐	☐	☐
• Using electronic entries	☐	☐	☐	☐	☐

Q10: We would now like you to think about general changes in the entries over time. Please indicate how much you agree or disagree with the following statements.

	SD	D	A	SA	N/A
• The quality of entries, in general, increased over my involvement in the ASC	☐	☐	☐	☐	☐
• By entering the ASC, students' skills in statistics, in general, increased	☐	☐	☐	☐	☐
• By entering the ASC, students' awareness of careers in statistics, in general, increased	☐	☐	☐	☐	☐

Q11: In what ways did you collaborate with schools and/or teachers on the ASC? Select all that apply

	Select all that apply
• I conducted Professional Development sessions with teachers	☐
• I held information sessions for students	☐
• I maintained a relationship working with school(s) or teacher(s) I had worked with because of the ASC	☐
• I maintained a professional relationship with teachers I had worked with because of the ASC	☐
• I held an award ceremony or prize-giving event	☐

Q12: Did your involvement in the ASC increase your engagement with schools or teachers in your region (compared to when you started involvement with the ASC)? (Yes, a lot; Yes, a little; No; Please explain.)

Q13: To what extent were the following issues barriers to successful collaboration between you and teachers/schools?

	Big	Minor	Not at all
• I was too busy	☐	☐	☐
• Teachers too busy	☐	☐	☐
• Students too busy	☐	☐	☐
• Support from university	☐	☐	☐
• University and school semesters did not align	☐	☐	☐
• Timing of the ASC due date and schools studying statistics	☐	☐	☐

Q14: In what ways did your university support your involvement in the ASC? (If you were at more than one university while involved in the ASC, please answer for the last university you were at when involved with the ASC. Select all that apply.)

	Select all that apply
• Formal recognition, though allocation in workload, money or in-kind support	☐
• Acknowledgement as an engagement activity at the university level	☐
• Acknowledgement as an engagement activity at the sub-university (i.e., Department; School; Faculty) level	☐
• Publicity opportunities	☐
• Not at all	☐
• Other (please specify)	☐

Q15: Approximately, with how many schools did you develop a continuing relationship as a result of your involvement in the ASC?

Q16: Approximately, with how many teachers did you develop a continuing relationship as a result of your involvement in the ASC?

APPENDIX B:
THE FRAME FOR THE SEMI-STRUCTURED INTERVIEW

General questions

- Tell us about your main role while involved with the competition (e.g., academic in statistics).
- Tell us about *why* you got involved in the competition
- What did you enjoy *most* about being involved in the competition?
- What did you enjoy *least* about being involved in the competition?
- What was the biggest *barrier* to making the competition successful?
- What would you change/wish was done differently? Explain.

How have you connected with schools

- Did you develop any relationships with schools and/or teachers?
  - If so: What was this connection that you developed with the schools/teachers?
  - Briefly explain some of the interactions that you had.
  - Tell us the sorts of things that this relationship entailed, e.g., visits to help with poster preparation; visit to discuss poster competition with staff, with students; present prizes; visits that emerged from competition but not directly related to competition.
- Did the schools acknowledge or show appreciation for your involvement? If so, how?
- Were there any schools with whom you developed a closer collaboration than others or that grew over time? What was the nature of these collaborations?
- Were there any schools you approached but that did not take up your offer (i.e., rebuffed)? Why do you think that happened?
- Many respondents said it was very difficult to connect with schools. If this was you, *why* did you find it difficult to connect with schools?
- We asked a question about how was your involvement acknowledged. How would you have *liked* your involvement to be acknowledged?
- Do you feel that your university saw value in your involvement in the competition, in enhancing engagement, and connections? Explain.

Imaginative questions

- Suppose money and time was no limit. What would you like to have seen done to make the comp more successful? Especially in regards to connections with schools.
- What advice would you give to someone, somewhere, who was starting a new statistics poster competition?

PETER K. DUNN
University of the Sunshine Coast
Faculty of Science, Health, Education and Engineering
Locked Bag 4, Maroochydore DC
QLD 4558 Australia