The impact of classroom design on collaborative learning

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Introduction

This paper discusses a trial of a recently opened Collaborative Learning Centre at the University of Queensland. The aim of the trial was to see how the space could be used with science students in a first-year introductory statistics course, and what kinds of collaborations the space might encourage. The Centre has a number of spaces designed for collaborative learning, but only one of these was completed at the time of the trial. This space was the largest, accommodating around 100 students in five 'pods', each with a main computer and data projector as well as six to eight other computers. It is clear that the space is not just a computer laboratory, with computers to support collaboration rather than being the focus. The trial attempted to use a learning task that would meet such characteristics of the space.

Since the collaborative space only became available midway through the semester, participation in the trial was optional since it was not included in the initial course description. To encourage attendance and to also reflect the value placed in the learning experience, students attending the trial were awarded a bonus 2% to their mark for the course. The trial was run as a two-hour session, once on a Thursday from 4 pm - 6 pm and then repeated the following day from 2 pm - 4 pm. The first session had 39 students attend (three pods of roughly 13 students) while the second had 69 (five pods of roughly 14).

In the two hours each pod was asked to undertake an investigation into mouth capacity and factors that might be related to it. A range of equipment was supplied, including measuring tapes and cylinders, stop watches, disposable cups, string, and water. Using water to measure mouth capacity was deliberately chosen to ensure that students would have to move around the space during the session (since water could not be used next to the computers). Each pod was randomly split into five 'podlets', of roughly three students each. Each podlet had a role in the investigation, as given in Table 1.

Table 1. Roles of students in the investigation

Experiment Designers	This podlet led the investigation by designing the study to be carried out. Their tasks included how to reliably measure mouth capacity, and to hypothesise what other factors might be related to mouth capacity.
Data Collectors	This podlet organised the collection of the data. They had to get the equipment for the experiment, make appropriate measurements about themselves, and then coordinate measurements of other pod members. They were also responsible for ensuring proper hygiene was observed, and returning the equipment.
Data Analysis	Once the experiment was decided and the data was being collected, this podlet researched the appropriate statistical methods for the summary and analysis of the experiment. Once the data was complete, they then carried out the analysis and provided advice to the last two podlets.
Paper Authors	This podlet was responsible for preparing a scientific paper concerning the experiment and its results.
Presentation Authors	This podlet was responsible for preparing a brief PowerPoint presentation concerning the experiment and its results

There was a lot that had to be done for this investigation in the time available, and it was thought that this could help encourage collaboration. However few explicit instructions regarding the collaborative aspect were given, beyond the simple task descriptions given in the above table. The trial looked at what collaboration would emerge from the space itself, given a suitable task and goals to achieve, as discussed below. Some advice on collaboration came from the pod leaders, and their role will also be discussed in the following section.

The investigations were brought to a close about 20 minutes before the end. The session then concluded with a mini-conference in which the presentation podlets each gave their short PowerPoint presentation.

Selection and development of leaders

Each pod of around 15 students was allocated its own group leader, generally a second or third year undergraduate student who had been successfully used as a peer assisted study sessions (PASS) group facilitator. Leaders were selected not only on the basis of their aptitude and enthusiasm for the discipline, but also for their communication and interpersonal skills (Miller, Oldfield and Bulmer 2004). In this context, they had also previously attended a facilitative skills development workshop aimed at explicitly defining their role in terms of fostering an active learning environment where students could be empowered to learn within a collaborative learning community.

Leaders were instructed in metacognitive and cognitive principles of learning, including the Socratic approach, by essentially being led themselves through a series of 'how to learn' based scenarios aimed at promoting dialogue and reflection within their group. These 'think tanks' were aimed at emphasising to leaders the importance of allowing each student the opportunity to generate his or her ideas and conclusions, rather than being spoon-fed. By using this approach, leaders could become adept at recognising characteristics of effective learning, viz. to be aware of the benefits of active versus passive learning, cooperation over competition, community over isolation, and to identify differences between surface learning and deep learning processes (Marton, Dall'Alba and Beaty 1993; Cross 1998).

In the collaborative learning centre environment, leaders learned to recognise when and how to vary their modes of facilitation in order to best promote knowledge constructs within their group (Herron 1999). Consequently, two important obligations of their role became apparent: firstly, to establish and scaffold the learning environment and secondly, to co-produce and co-direct their students' learning.

In this regard, the direct relationship between students' level of engagement and the extent of their active involvement in the learning task shown by Biggs (1999) served as a guideline that leaders ought to adopt in their facilitative role: to direct students' learning processes and not act merely as conduits of information flow between academics and students. Within their pods, leaders were expected to play a key role in building a strong environment to allow the group to raise and explore its own questions. Leaders attempted to generate enthusiasm about the learning task, directed student involvement, introduced 'leading' questions, analogies or examples, and yet tried to create sufficient space for the group to participate in its own learning.

Within each pod, leader-student and student-student interrelationships were expected to form a focal point for learning. The students were asked to work cooperatively in podlets of three to four students so that the work of each pod could not be accomplished without each and every member doing his or her part. In each session, relative participation by students and leaders in knowledge construction could change according to the task, so that learning became an experiment in leadership and was dependent on the expertise of both leaders and students. The challenge for each leader was ultimately to recognise the value of each student's, or podlet's, contribution towards reaching the

shared goal(s) of the pod and to attempt to extend their contribution to the limit before the podlet's collective contribution was incorporated into the pod's knowledge pool.

Observing students' activities

Observation foci

In approaching the task of observing students within the CLC space, we decided to focus on three distinctive types of activities:

1. the behavioural activity of the pod and podlets – what the students *did* in an organisational sense;
2. the learning-oriented activities of students within the podlets – the degree to which students *engaged* in the subject matter of the task; and
3. the frequency and type of *interactions with tutors* – either sought by students or offered/ intervened by tutors.

We also wanted to consider how these activities played out within various stages of the investigation, particularly since the intention of the task design and use of space was to facilitate both collaborative activities and cooperative learning. To do this we focused observations of each of the above activities within distinct 'stages' reflecting the stages of the investigation task – organisation of podlets/experimental design; experimental activity; conclusion/presentation and paper.

This also meant that we could begin to hypothesis about the types of activities each stage would elicit – in both a behavioural sense and a learning sense. For example, we anticipated that in the initial stages of the tasks students would be more heavily engaged in behavioural activities (getting organised, allocating roles, clarifying objectives etc); and that the second and third stages of the task would require greater engagement in learning or knowledge-based concerns (such as creative thinking towards the design of an experiment, and inductive thinking towards the selection of data gathering strategies).

What we saw – a vignette

Whilst our actual investigation involved three educational researchers in the focussed observation of one pod of students each, it is more economical in this paper to present a representation of student activities within an illustrative vignette documenting one pod:

> Having been divided into five podlets of approximately 3-4 students, there was some hesitation. At this point the tutor spoke to the whole pod, encouraging each group to begin their respective tasks, and at times, reiterating the task directions. The tutor used the large screen to draw students' attention to the task outline that was provided on the course website, and to point out important links that were provided for student use. The tutor encouraged each podlet to remain active throughout the task, suggesting regular interaction with other podlets, and lots of teamwork by comparing notes, checking outcomes, sharing ideas.
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> Within each podlet one or two students began to speak to their fellow students – sometimes making suggestions, at other times checking understanding via questions such as 'So… what if we get some way of measuring mouth capacity? How many should we take?' For the experiment designers and data collectors, this seemed to be enough to stimulate activity. Plans were quickly made and agreed to, and this was communicated by one or two students to the other podlets (generally these students demonstrated a predisposition to leading the group and initiating ideas, which continued throughout the activity). Within various podlets roles began to be allocated, with a consistent pattern of one or two students 'taking charge' within the podlet, and the rest 'hanging back' or following along.

For a few minutes the whole pod seemed to be engaged in busy activity, mostly discussion and joking about what they should do next. However there is little discussion between podlets, and there has been no shared discussion or agreement about how to attend to the task at the whole of pod level. The tutor has become aware of this, and intervenes again, this time canvassing students for ideas about what they might measure, how they might measure, and which factors they think may be worth considering for the task. The whole pod listens, but the same 3-4 students respond and initiate ideas – those students are in the research design and experimental design podlets. Once the tutor has finished talking, discussion continues amongst the podlets. In scanning the podlets the observer notes that at this stage discussion is more task directed, and plans are being made for undertaking respective podlet tasks.

The data collectors and experiment designers leave the pod space and move to the front table containing the equipment provided. A selection of materials is taken outside, and within this group a process is negotiated for data collection – which is slightly modified as they go along. Some students notice limitations in their process (holding the measuring cup to eye level makes the level of water uneven – placing the cup on the concrete slaboratoryand bending down to view the water level is more accurate), and so a group decision is made about refining the process. At this point the question of 'what else to measure' is raised by one student. The others quickly confer that they need to consider possible factors that might be related to mouth capacity (which reflects the earlier hints made by the tutor).

Eventually, through discussion amongst some students, it is decided to increase the sample size to include the entire pod, and to measure jaw length, head circumference, height and sex. Other pod members are gradually collected from inside, and more data gathered. At this stage, the 'process' of data gathering has 'evolved' with several members of the team forming a 'production line' style process (water provision + measurement; water capacity recording; jaw length measurement, height etc. with three different measurement recorders following each participant through the entire process).

In the meantime, podlets involved in the other tasks have remained inside and have also begun to take action. Most of these students are clustered around computers, within podlet groups. The paper authors discuss the structure of the paper and begin to search for relevant papers on the web. A preliminary paragraph detailing the experimental design is drafted, with one member of the pod typing, one collaborating, and another is actively gathering information from the other pods (e.g., noting the detail of the experimental design, asking the data analysis group what they will be doing etc).

The data analysis group was also quick to commence work, with initial division of tasks between students to identify possible statistical methods for the summary and analysis of the experiment. The tutor spent much time with this group – who eventually got out their text book and sat side by side flipping through various chapters, trying out tools on the computer, and asking questions of their tutor. Eventually this group became impatient for data – keen to try out the selected strategies and commence analysis. As decisions were made members of this group would often convey decisions and strategies to other podlets (the paper authors and presentation authors particularly). Once data became availaboratoryle, this podlet became very busy with the process of summary and analysis – again, the tutor was called upon, reinforcing analytical observations, consolidating students' understanding of meaning and findings etc. At this point, as the data gathering had been completed, many students were gathered around the data analysis group, keen to see the outcomes. Some became disengaged, as it was difficult to hear and participate. Some wandered over to the author podlets, and many sat back simply waiting around and chatting.

As the analyses began to firm up, the paper and presentation authors were also keen to get some findings, to enable them to consolidate their work. Until that time the paper authors had been relatively busy, but the presentation authors had spent much time selecting powerpoint templates and writing introductory slides. At this point much information needed to be shared across each of the podlets – the factors that were decided upon (as the basis of a hypotheses, however the notion of a 'hypothesis' was not spoken about by the students but suggested by the tutor), how they were measured, why, and the findings etc. Students from the design podlets provided this information to the authoring podlets. There was also some discussion about data sharing – and some students then worked across their podlets to figure out some way to begin saving data summaries on the web so that students in authoring podlets could begin writing up the summaries.

Once it seemed clear that all podlets had completed the data collection phase, the lecturer reviewed the progress of each group by using the main screen at the front of the CLC to switch between each groups' powerpoint presentation 'in progress'. This facility enabled an update to take place, and many students responded to the implicit prompting and guidance this provided. Eventually, with several prompts, students were asked to complete their presentations, save their papers to the website for others to read, and to prepare a short presentation of their findings. This stimulated a flurry of activity in this pod, with two or three students (those in the powerpoint presentation podlet) hurrying to finalise the presentation. They checked with other students about the key findings and presentation points. Some were only engaged in finding pictures and formatting. Many others at this point were sitting back, waiting. Once the pod presented, all students were engaged, listening intently and nodding in agreement or sharing the odd joke about findings.

Developing an hypothesis and evaluating outcomes

The research team initially had different perspectives on what particular aspect of the new Collaboratoryorative Learning Centre (CLC) to focus on in order to determine whether or not the design of the new 'high tech' purpose-built classroom impacted positively on student learning. An emerging consensus developed following the first stage of the trial which involved three direct observations of groups of science students undertaking practical experimentation and statistical interpretation, including the one presented in the above vignette. There are several key issues still to resolve that are at the centre of the research team's deliberations. The first consideration is to ascertain whether the planned activities and student outcomes that derive from collaboratoryorative learning activities in the CLC are significantly better than those achieved in 'conventionally designed and equipped' classrooms. The initial indications are that strategies to promote collaboratoryorative learning can be employed in any physical space, but the CLC technology, podlet design and ease of dividing the room into whole class or sub-divided units strongly facilitates group collaboration and teamwork.

The second consideration arising from the trial observations is whether a strategy of total immersion into a new, challenging and different learning environment provided by the CLC is the most appropriate form of student induction. Educational theory that underpins the establishment of learning communities suggests that the use of socially oriented pedagogical approaches, enhances the overall learning process (Moore and Brooks 2000), decreases rates of attrition (Staasen 2003) and facilitates the transition from student to discipline professional (Lave and Wenger 1991). These positive student-learning outcomes are likely to be achievable in the medium to long term through reinforcement of collaborative learning expectations and continued exposure to the CLC facilities and their interactive potential. However, many of the science students that were immersed in the different learning culture within the CLC were cautious in taking on a group leadership role or contributing beyond the boundaries of their allocated group task. A strong sense of social interaction among individuals as well as group identity and cohesiveness are attributes of effective learning communities, as identified by Austin (1985); these features may take time to develop. The group leaders, who guided the work of each podlet, adopted a more directional approach when mapping out

to students what the overall intention of the practical statistical investigation was in subsequent trial observations. As a consequence there was a greater sense of coherency and purpose demonstrated by most groups leading to the first signs of authentic learning (Newell 1999).

The evaluation of learning communities is important in establishing whether implemented models, activities and planning have met their intended outcomes and purpose. At the heart of the design of the CLC was the capacity to promote social interactions, to enable students to build a degree of emotional bonding and, as a consequence, develop a supportive and collaborative environment. The research team is at the early stages of developing an appropriate model to record, determine and contrast the impact of collaborative learning experiences in different classroom settings. The Psychological Sense of Community (PSOC) scale developed by Saroson (1974) is an appropriate method of determining the attributes that individual students possess from their participation in, and belonging to, a learning community. Another potential development is to establish criteria which map the way in which collaborative learning experiences in the CLC contribute towards meeting graduate attributes, many of which are common to Australian Universities.

For the initial trial observations a series of evidence-based questions and a detailed recording sheet were developed which have been subsequently refined. Key questions ranged from the simple to the specific. For example, 'Did the activity help students see the relevance of statistics?' and 'What evidence was seen of students using inductive logic, creative thinking or educated guesses in the development of hypothesis?' The research team made an assumption that students would be operating conceptually at a higher level than was observed in practice. The knowledge and understanding of statistics demonstrated by the majority of students was at least secure, and good for some. However, student skills in developing an hypothesis before experimentation and elucidating and explaining the outcomes of their group's findings were relatively underdeveloped or implicit.

This trial of a single session will be extended in October 2005 to a four-week trial involving 480 students in groups of up to 180 at a time in the CLC spaces. The main outcome of the work presented in this paper has been to refine the criteria that will be used to assess the positive learning outcomes from the use of specific pedagogical strategies in the CLC. The current criteria are listed in Table 2. Before the full scale observations begin in October, it is already clear that the proposed criteria which relate to conceptual understanding of experimental design (B), group leadership (H) and assumptions about 'deep learning' (J) will require close scrutiny and investigation.

Table 2. Proposed criteria for evaluating activities in the CLC

Open-ended approaches to teaching and learning within the CLC lead to:	
A	higher levels of student engagement;
B	a clearer conceptual understanding of experimental design;
C	better opportunities for learners to construct, test and evaluate the effectiveness of experimental tasks in groups;
D	increased opportunities for students to exercise autonomy and control in making decisions;
E	the effective integration of ICT technologies to improve shared group communication;
F	the promotion and sharing of different ideas and dynamic group learning practices;
G	an understanding of 'real-world' problem solving and workplace challenges;
H	student leadership skills being developed and extended;
I	the longer term development of strong interactive learning communities;
J	the cumulative impact of collaborative learning experiences is deep meaningful learning

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