Room for Improvement: the effect of changing learning spaces

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ABSTRACT
As student engagement becomes more important, alternative techniques and technologies to enhance their participation need to be explored. One consideration is the learning environment and at the start of 2013 the Eastern Institute of Technology (EIT) installed an alternative computer classroom layout where computers were configured into "pods". The purpose of this paper is to briefly review the literature surrounding learning spaces and using the EIT pod room as a case study, identify whether the physical environment enhanced good pedagogy by asking staff and students to describe their experiences. Based on the feedback a list of recommendations has been developed that others can use when considering alternative configurations when setting up their own computer classrooms.

Categories and Subject Descriptors
K.3.1 [**Computers and Education]**: Computer Uses in Education – *collaborative learning.*

General Terms
Human Factors

Keywords
Learning environment, student engagement, learning spaces

1. INTRODUCTION
In the New Zealand tertiary sector it is becoming increasingly important to retain students and this is reflected in the Educational Performance Indicators (EPI) that each institute is measured against and subsequently have an impact on funding [7].

One way to increase retention is to increase student engagement and participation, and in this the learning environment can play an important role. Graetz [3] highlighted its importance and stated "the physical characteristics of learning environments can affect learners emotionally, with important cognitive and behavioral consequence". Based on experiences in other organisations, at the start of 2013 the Eastern Institute of Technology (EIT) installed an alternative computer classroom layout where computers are configured into "pods" as shown in Figure 1.

Staff and students have been using the new configuration since the beginning of 2013 and there is an opportunity to follow up their experiences to determine whether the initial advantages have and are being realised.

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Figure 1: POD Room Layout

A case study approach was chosen, however unlike earlier studies which concentrated on the physical layout [8, 9] the principal research question of this paper considers whether the room enhanced good pedagogy and student participation.

In order to provide a framework this paper discusses the results based on a well-known study into good practice in undergraduate education by Chickering and Gamson [2], and looks at the following questions:

1. What are the benefits of this configuration to students and educators?
2. What are the issues and disadvantages of using this configuration to deliver courses of learning?
3. What lessons can be applied to the process of altering physical learning spaces that could be of use to others in the future?

Since it is becoming more common for students to *bring their own devices* (BYOD) the ability for the room to cater for this was also considered.

This paper concludes with a set of recommendations that others considering alternative configurations can consider when setting up their own computer classrooms.

2. LITERATURE REVIEW
In their well-cited study into good practice in undergraduate education (over 3,600 citings in Google Scholar), Chickering and Gamson [2] proposed that good practice in undergraduate education:

1. Encourages student-faculty contact.
2. Encourages cooperation among students.
3. Encourages active learning.
4. Gives prompt feedback.

5. Emphasizes time on task.
6. Communicates high expectations.
7. Respects diverse talents and ways of learning.

They intended these seven principles to act as a guide to educators and administrators as to how to include good practice in undergraduate education, and recognized "that content and pedagogy interact in complex ways" [2, p. 4].

Other studies place the learner at the center, and identify that the effective learner constructs their own knowledge (Chickering and Gamson's point number 3). Six principles of constructivism are described by leading authors Biggs and Tang [1] as:

1. Learners need guidance and support;
2. Learning is best facilitated when students' prior knowledge is 'cued';
3. Learning occurs through communication and social interaction;
4. Learning is not a spectator sport;
5. Deep understanding occurs when students are able to apply their knowledge to new situations; and
6. Students learn better when they are aware of their own learning processes".

Van de Blink [6] notes that computer laboratories were initially developed to allow students to complete assignments and learn computer programs, but have evolved, and suggest that the design and configuration of computer labs "transform into flexible, technology-enhanced spaces for maximum effectiveness."

In 2003 Young and Hubbard [8] found "very few references [in the literature] and no definitive theory or argument on optimum design and layout was obtained." Many institutes they visited chose layouts either because it was the way they had always been laid out or to fit as many computers as possible in the room. Three common layouts they observed were computers around the walls, computers in rows with all students facing the front, and the computers in double rows with students side-on to the front of the room [8].

In 2004 Young and Mann [9] further noted a lack of theory about the interaction of learning styles and physical spaces; They noted: "When considering the new layouts it is equally important to consider the teaching styles of the academic staff and find out what they required in a computer laboratory". Both Young and Hubbard [8] and Tansley [4] surveyed academic staff about their requirements and desires for new computer lab layouts. Similarly at Cornell University van de Blink [6] used focus groups and surveys of staff and students to identify different uses and needs for computer labs, combined with observation of actual use.

Tansley [4] noted that "teachers have different methodologies that require particular needs in the layout of the room." The main requirements she identified from teaching staff were to see the students' faces to check if they were engaged, for students to be able to see the whiteboard/projector and their own screens without too much disruption, and the ability to engage with the students without screens. She also identified the desire for spaces for group work, and/or books and notes, the ability to have computer desks and non-computer desks in the same room and flexibility to change the layout around as needed.

Young and Hubbard [8] identified four main requirements: the requirement for a theory space in a practical environment, to be able to see the student screens from the front of the room, the opportunity for students to do group work, and a way to manage "the difficulty of inattentive students who did other things (e.g. playing games, surfing the net, reading emails) during the class".

Young and Mann [9] also noted that "in teaching technical computing (as opposed to end-user computing or computer-aided teaching of other subjects)" there is often a need "to teach theory in a practical setting". They propose the following needs for specialist computer education:

> Students need to be able to see the lecturer and whiteboard without distraction; the lecturer needs to be able to see all the student screens; the lecturer needs to be able to get to sit beside each student to work with them; the students need space, not just for themselves or copy material, but technical material which might mean several books, diagrams and manuals; students need room for group work.

They further noted that when teaching about computers "we might move from explaining some concepts to implementing them using computers - and back again - several times in a single session".

Van de Blink [6] also found that the location of the computer lab influenced its character: a lab near a library would become a quiet learning space, whereas a computer lab near where students congregate would become a more collaborative learning space. She further notes that "small changes at small cost can be effective and efficient" and recommends continually reviewing lab and space needs for teaching, rather than looking at redesign as a one-time project.

3. RESEARCH DESIGN / METHOD

3.1 Physical room design

EIT has a history of experimenting with learning spaces [Hilton, D, personal communication, June 26, 2013]. The Head of the School (HoS) of Computing and EIT's Corporate Services, Capital Planner proposed experimenting with new computing lab layouts after they attended a conference on learning spaces, and after seeing alternative lab layouts in Australia (an example is shown in Figure 2) and New Zealand secondary and tertiary institutes " [S. Corich, personal communication, June 24, 2013].

Figure 2. Example of a future teaching space at Melbourne University

The overriding objectives of the room were to consider the needs of the 21st century learner, and better engage Gen X and Gen Y learners. This lead to the specific objectives of:

- Creating a multifunctional, group collaboration learning space.

- Moving away from the more formal tutor controlled/focused environment to an environment that encouraged group interaction and teacher facilitation rather than the 'sage on the stage' approach as suggested by Biggs and Tang [1].

A secondary consideration was to attempt to expand the room capacity without compromising either teaching quality outcomes or acceptable circulation space restrictions.

3.2 How the design was chosen

Important design considerations were student vision to room activity, and the idea that through the use of appropriate software visual presentations could be imaged on each individual PC rather than a reliance on front of class whiteboard or data projection (again this needed to be experimental and a definite change from traditional front of class teaching methodology). This has proved to be technologically challenging and at this stage has not been implemented.

As mentioned earlier, the HoS and Capital planner visited tertiary and secondary institutes in Australia and New Zealand, attended a learning space conference, and considered literature on collaborative learning spaces [3].

The design chosen was a simplified version of the Melbourne University trial space shown in Figure 2 [5].

The hardware decision was made following suggestions from IT Services, the adoption of integrated (one piece) units was made to reduce the amount of desk space required for computers [3].

3.3 Survey design

A questionnaire was developed based on Chickering and Gamson's [2] seven principles of good practice in undergraduate education. Two slightly different versions were created: one for lecturers and one for students. The questionnaires were then tested for face validity and pre-tested for content validity by a lecturer and a student.

The questionnaires were then administered to lecturers and students who had used the pod room in semester 1 of 2013.

For the students, 19 filled in the survey, of which 58% (11) were female; 53% (10) were under 25 and 21% (4) over 40; 32% (6) had no prior tertiary education with 32% (6) holding a degree or postgraduate qualification; 32% (6) indicated they were confident computer users (able to manage files, use the internet and a variety of applications) and 68% felt they were proficient users (happy to provide assistance to others).

For the staff, 6 filled in the survey, of which 83% (5) were female; all were over 35; 50% (3) holding a degree or postgraduate qualification; all indicated they were proficient users (happy to provide assistance to others).

Results were then analysed.

4. FINDINGS, ANALYSIS AND DISCUSSION

4.1 Survey results

Figure 2: Students using the POD room

4.1.1 Overall Impressions

The first question asked was for the overall experience with the pod room. As shown in Figure 3.1 74% (14) of the students felt the room had a positive impact on their overall experience, although with issues raised in the comments section (see section 5.1.2 below).

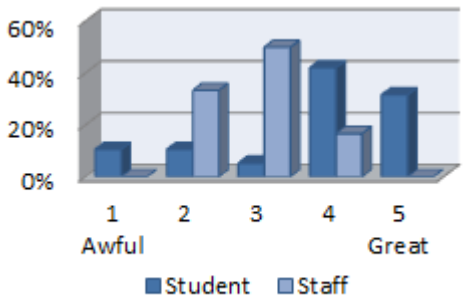

Figure 3.1. Overall Experience

Staff results indicated a neutral overall experience, with no one identifying it as either awful or great, and again with issues raised in the comments (detailed in section 5.1.2 below).

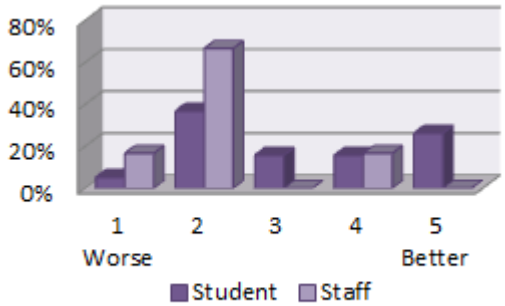

Figure 4. 2:v's standard layout

The second question asked for a comparison of the room to standard layouts, and at EIT this meant arranged in rows. As can be seen from Figure 4 there was an even split of students

preferring the different layouts with 42% for worse (1 + 2) and 42% for better (4+5). Student comments tended to cluster around the visibility of the whiteboard, with one commenting: "Pods are great if the whiteboard is not used but as soon as a whiteboard is required everyone need to be facing the front of the class". Comments here suggest that the pedagogy being used needs to be considered, so sessions where demonstrations occur at the front of the class are not well suited to this layout.

From a staff perspective almost all indicated that the layout was not as good as the standard as they needed to demonstrate from the front. One indicated they moved their class and another would ask for a different room. An interesting comment was: "Would work better in a student hub where teaching/learning is not taking place and students are working in isolation, e.g. no group work".

4.1.2 Benefits and Issues

The third and fourth questions asked for benefits/advantages and problems/disadvantages, and respondents were asked to rank these. For the majority of students group interaction was identified as the main advantage, with the pods actually facilitating groupings. The amount of space in the room, screen privacy, and the ability for groups to congregate around a particular computer were also cited as advantages (these were also mentioned by staff).

For disadvantages, the most significant was the difficulty for those with their backs facing the whiteboard, and it was noted that it was also uncomfortable to look diagonally at the board. The size of the smart board was also highlighted plus problems for "*vertically challenged*" students who would have difficulty looking over the pod. Several students mentioned the lack of space on desks for course materials, books and folders, or a device such as a laptop or tablet. Amongst other comments students indicated that the layout allowed for privacy, but that student to student interaction was quite disruptive due to the separation distance.

Similar comments were received from the staff. The main perceived advantages for staff included the "informal atmosphere" and the "It is easier to 'float' around the room and mingle" plus the increased space around students.

However, comments indicated issues with demonstrating, for example "It was awkward to use for a demonstration show and tell type class room where most of the teaching is done using the PC and datashow" The placement of the tutor PC attached to the datashow meant that "people are looking elsewhere (the whiteboard) when I am talking" and "cannot see the datashow easily" or "make eye contact"; and the distance of the PC from the smartboard meant "downtime scooting back and forth". Other issues regarding the smartboard were more apparent than with the older layout: the fine control required by some applications (such as working with Spreadsheets) is difficult on the smartboard and needs easy access to the tutor PC.

Other issues raised by staff were that there is nowhere to set up books, handouts and materials, leading to time wasted finding the materials when needed ("No breakout space for collaborative work"), a lack of privacy when having a discussion with an individual student, difficulty for students to collaborate as "there are computers between them, and they can't see each other's screens", and also "Students don't have much space to spread out books or put a laptop as a secondary device".

4.1.3 Pedagogical Questions

To understand the pedagogical effect of the layout, several questions were asked based on Chickering and Gamson's [2] good practice principles.

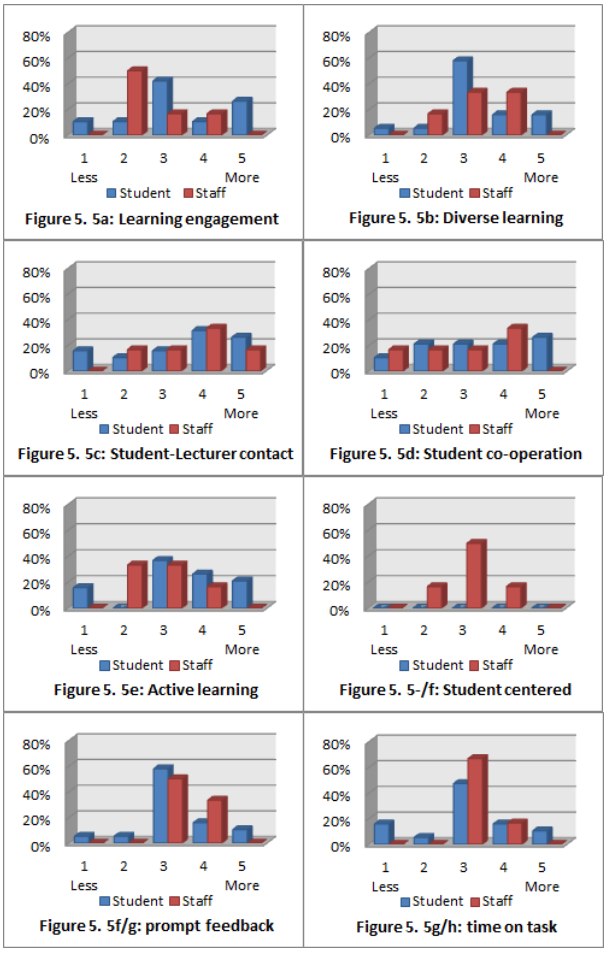

Figure 5. 5a: Learning engagement | Figure 5. 5b: Diverse learning

Figure 5. 5c: Student-Lecturer contact | Figure 5. 5d: Student co-operation

Figure 5. 5e: Active learning | Figure 5. 5-/f: Student centered

Figure 5. 5f/g: prompt feedback | Figure 5. 5g/h: time on task

Based on the quantitative feedback (Figure 5) it is important to note that the room layout overall has not significantly affected the factors identified by Chickering and Gamson [2]. There are positive indications that the room layout for both staff and students has allowed for diverse learning opportunities (Figure 5. 5b), increased student to lecturer contact (5c), improved feedback (Figure 5. 5f/g) and time on task (Figure 5. 5g/h). Students also indicated a small preference for improved engagement (Figure 5. 5a), student co-operation (Figure 5. 5d), allows for more activities (Figure 5. 5e), and feedback (Figure 5. 5f/g). Students made few comments on their responses. Some included the layout created a "friendly environment, good icebreaker" but there were "more distractions from other students". Another commented that interaction was "forced" and made the class "uncomfortable" and had a "negative effect on their learning", and responded to an earlier question that they "regularly skip classes held in this room".

An interesting student comment was that "Having filled this (survey) in I realise there were quite a few benefits to the set up, in that it made it a more relaxed interactive class with the pods, rather than rows of monitors, with students more isolated in their spots".

Few comments were made by staff although one observed "I think it encourages active learning and student-centered learning because the room is very unsuitable to lecturing, so the lecturer has to plan other sorts of activities."

The final question asked staff and students to identify what could be done to improve the room. As noted above, student comments mentioned the whiteboard visibility and size, as was computers where student had their backs to the board. One student suggested a mixture of rows and circular tables and increasing the size of the individual desks, thus allowing for more book space to spread out. For the pods it was suggested that the mid-sections could be lowered, and that the screen facing away from the front be removed. The staff comments unanimously indicated the need for a tutor desk with room for materials and a computer facing the room. Students observed the distance tutors were covering between the smart board and the tutor computer. Comments also included that the smart board needed fixing (later identified as a software issue and is currently being tested). One of the staff commented that "workshops work really well in the room at Te Manga Maori where the PC's line the outer wall of the room and the middle of the room has a large table where discussions and group work take place. The computers are not a barrier to discussion/group work but are rather a place where you can slide your chair off to and work/practice skills when necessary."

Additionally, comments were sought from the Head of School. His concluding comment was "The pod room has given us an opportunity to try something different. To me it has made me aware of the increasing reliance of teaching staff on technology solutions that work and the benefits that can be gained by making a computer lab a more informal space" [S. Corich, personal communication, June 24, 2013].

5. DISCUSSION

The findings seem to show that the layout was a cautious success, with some issues identified for further consideration. Taking into account the original objectives for the room, some observations are as follows:

- Multi-functionality: Intuitively, the room seems to be flexible for different sorts of learning activities, but responses indicate that this has not necessarily worked in practice. Small tweaks in room layout or facilitation methods may reduce distractions, make group break-outs easier, or enable non-obvious private conversations.
- Responses and comments indicate mixed success at facilitating group collaboration. Some learners also stated a distinct aversion for group work, (as an aside this regularly surfaces in student evaluations) and thought needs to be had as to how the space can be adapted to allow people to "opt out" of collaboration where appropriate.
- Comments indicate that the space does discourage the "sage on the stage" approach, but from feedback in many learning sessions it is appropriate for some amount of teacher-led activity such as class discussions, software demonstrations, and small bites of new information. Several concerns could be addressed if the room catered for this delivery style, and as suggested by Young and Mann [9] "in teaching technical computing ... there is often a need... "to teach theory in a practical setting".
- The layout did successfully allow for expanded room capacity, with the number of computers increasing from 24 to 30, while still feeling spacious and providing more space to move around. This has been a big success.
- Student vision across the pods or across the room was obstructed by high screens. Removal of one computer (back facing the smartboard) and reducing the height of the pod could be solutions, but the implications would need to be thought through.
- Software presentations projected from individual screens was not implemented due to technical difficulties. If this were implemented this could have allowed a tutor computer to be in one of the pods as opposed to off the side.

Pedagogically, the findings indicate that the room layout may provide slightly more allowance for diverse ways of learning, improved student lecturer contact, more prompt feedback and more active learning and 'time on task', but in all areas responses were mixed. Responses also seem to show a slightly decreased learning engagement and student co-operation, with little effect on student-centeredness. With such a small sample size, these can only be relied on as indications - however, they raise interesting questions, particularly as increasing engagement and allowing for constructivist learning were reasons for choosing the room layout.

The advantages identified were:

- improved group interaction in some cases (although some respondents reported that group interaction was actually more difficult);
- screen privacy, but this was also a disadvantage when students wanted to work together;
- the ability for groups to congregate easily around a particular computer;
- a more informal, 'friendly' environment; and
- more space in the room, allowing students and staff to move around the room easily.

The disadvantages to students which were related to this room layout were:

- Group interaction was harder in some cases because students were further away from each other, although others reported more group interaction;
- Students had to move to work together, as they couldn't easily see each other's screens;
- Some students disliked being unable to remove themselves from a group setting;
- Students reported more distractions from other students;
- Computers with their backs to the whiteboard and smartboard were unusable when tutor-led discussion occurred;
- Students using the rear computers had difficulty seeing the whiteboard or smart board because of computer screens and people; and

- There was little room on the desks for books, folders; paper - or a laptop or tablet. This is a significant limitation particularly if students bring their own devices.

The issues for staff (which become disadvantages to students) were:

- The room is challenging for teacher-led discussions or demonstrations on the smartboard, and it is noted that almost all classes - however student-focused - need to include some of these.
- A lack of privacy when having a discussion with an individual student; and
- The lecturer's computer and smartboard were separated by a significant distance:
    - It was awkward for the lecturer to move backwards and forwards, breaking the flow; and
    - Students were looking at the smartboard, not the lecturer, so the lecturer could not use body language or expressions to direct attention.

As noted by the Head of School [S. Corich, personal communication, June 24, 2013], lecturers increasingly rely on a smooth technological environment, so it would be useful to consider this issue further.

Other things we learnt:

- It would have been good to have had a quick meeting of those using the room early on, so that teething issue could be identified and in some cases fixed.
- Staff need to be proactive in taking responsibility for logging problems and seeing them fixed (which is a different, ongoing issue). This may have helped sort out the precision issue on the smartboard.
- It would be good to have a reporting system to log suggestions and issues related to the teaching (rather than technical which is separate), such as the size of the smartboard – which could be a campus wide issue not just in the computer labs.

5.1 Internal Recommendations for this room

From the survey responses, the authors would recommend the following:

- Adding a table for the lecturer materials. If it was of sufficient size and included the tutor computer this could also be used for non-computer related group work.
- Assessing smartboard size and whiteboard, smartboard and projector visibility across all computer labs at EIT.
- Adding quick room evaluation questions to the regular course evaluations.
- Position the lecturer's computer nearer the smartboard, facing towards the students, or allowing for one of the class computers to be used instead.
- Consider how to cater for students with their backs to the whiteboard
- Consider increasing the size of individual desks to allow for books, handouts, paper, and laptops or tablets.
- Consider lowering the heights of screens, allowing students to interact over the screens and also see the whiteboard and smartboard more easily
- Continue evaluating this room; draw up specific objectives for the room in light of the initial evaluation, and evaluate their success.
- Experiment with a range of group collaboration layouts as well as the pods, such as outward-facing curves.

The authors realize that some of the recommendations will be difficult to implement but have them included should further rooms be planned or for other institutes who may wish to use this model.

6. CONCLUSION

It is exciting and motivating to experiment with new ways of teaching and innovation is one way to achieve this. Continuous improvement occurs through critically evaluating existing systems and looking at how these systems can be refined. Regarding the success of the pod room layout, preliminary evaluation of pedagogical aims and student and lecturer opinion showed mixed results, although a slight positive indication, when compared with a traditional computer lab laid out in rows.

There is some concern however with the adaptability particularly for providing an area to place laptops/tablets where students bring their own devices.

Regarding the experimentation with new layouts, useful factors in the experimentation include gathering design considerations from the literature, other institutes and a range of staff and students in a range of programmes and levels; forming clear pedagogical objectives for the room; quick evaluation early in the term to identify any easily-fixed problems; and evaluation of the room against pedagogical principles and its objectives, as well as student and lecturer opinions.

Results of this study line up with those identified by Tansley [4] and Young and Hubbard [8], namely the requirement for teachers to see students' faces, for students to see a shared display (smartboard) space, an ability to engage without screens, a space for additional materials, a way for facilitators to monitor what students are doing, and an ability to cope with a variety of teaching techniques (including teaching from the front).

Some advantages highlighted included space for staff to move around the room, space for students to congregate around any PC, screen privacy, and a more informal 'friendly' environment.

As noted above, these findings are preliminary, and show results from a small sample size. Both authors have taught in the POD room, which does introduce some natural bias, although care was taken to reduce this wherever possible.

The literature consulted was from Educational Technology sources. It is likely that Workplace Design and Architecture sources could provide useful additional research to inform computer lab design.

6.1 Limitations

One significant limitation of the study is the small sample size, and that the results only span one semester. However, it was felt that as this was "new" there is real benefit in capturing feedback in the early stages to allow improvements to be made if necessary and before some of the issues in implementing a new layout have been either remedied or work-arounds developed.

Both authors have taught in the POD room, which is the motivation for the research, and were keen to provide constructive feedback to the Institute so that improvements (if needed) could be made to the existing room or modifications could be considered if further rooms were to be implemented. However, this does introduce some bias. In order to manage this bias, one of the authors did not complete the survey and in the paper has made explicit reference to any comments added. All survey results were anonymous, however with the small sample size some tutors/lecturers could be identified.

6.2 Ethical considerations

The survey was conducted online and the technology used does not allow individuals to be identified. With such a small sample size care was taken that the questions would not easily identify students.

7. FUTURE WORK

The research will now enter a longitudinal phase and we would like to continue evaluating the effectiveness of this layout as improvements are made and staff and students adapt to the new environment.

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Appendix A: Student Survey

1. How would you rate your overall experience with the pod room? Please try not to rate the quality of the course or lecturer.
(1-5) + Comment)

2. Is it better or worse than a standard computer lab configuration?
(1-5) + Comment)

3. What do you think were the benefits or advantages of the pod room layout?
Please number in order with 1 being the highest benefit.

4. What do you think were the problems or disadvantages? Please number in order with 1 being the biggest problem.

5. Did the pod room layout ...(1-less to 5-more)

5a. ... Make your learning engaging?

5b. ... Allow you to learn in different ways?

5c. ... Encourage contact between you and your lecturer?

5d. ... Encourage you to work with other students?

5e. ... Enable you to do learning activities (e.g. discussions, exercises, working on assessments)?

5f. ... Encourage prompt feedback?

5g. ... Encourage time to be spent on class activities?

5h. ... Encourage you to produce better work?

5j. Any comments:

6. What do you think we could do to improve this classroom? Please number in order with 1 being the highest improvement.

Something about you

- Gender
- Age range
  (< 20, 20-24, 25-29, 30-34, 35-39, > 40)
- Highest prior tertiary education
  (None, completed undergraduate diploma, completed level 5 or 6 degree, hold a degree, hold a postgraduate qualification)
- Indicate your level of computer confidence
  (Novice (rarely use), OK (happy working on a computer), Confident (can manage files, use the Internet and a variety of applications) , Proficient (happy to provide assistance to others), Expert(would be considered a power user))