

# Shared access to computers promotes group interaction in an active learning classroom

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Active, collaborative learning offers advantages over traditional instruction across a broad range of disciplines. Recently, classrooms have been redesigned in order to better promote group interaction and discussion, with de-emphasis of the front of the classroom, students being arranged in small groups, and ubiquitous presence of technology. Student tutorials were held in an active learning space designed for students studying biomedical science. A unique feature of the space was that it had two computer configurations installed: some desks were configured with one computer per student while others had a shared configuration of one computer per three students. The presence of two different configurations in the same space allowed a single cohort of students, all learning the same material and with the same teachers, to experience both configurations and make direct comparisons. Staff and student opinions were gathered by anonymous survey.

Student preferences for computing configuration were divided. Students who preferred one computer per student reported that this enabled faster completion of set class activities. Students who preferred the shared computer configuration stated improved learning, better engagement and more group cohesion. Overall, both teachers and students found that the active learning classroom promoted engagement and group interaction. These observations support previous studies that found active learning classrooms and computer sharing among students leads to better group interaction and outcomes. Shared computer facilities can promote group interaction and may lead to better outcomes for learners. These results may be of interest to universities or schools designing educational facilities to promote group learning.

## Introduction

The pedagogical benefit of students learning in groups is well established (for a comprehensive review see Johnson & Johnson, 2009). Across a wide range of disciplines, didactic methods are being supplemented or replaced by more active, collaborative approaches to learning. In science education, these methods have been shown to lead to more engagement from students and greater retention of knowledge than traditional classroom teaching (Burrowes, 2003; Hake, 1998; Trempy, Skinner, & Siebold, 2002; Udovic, Morris, Dickman, Postlethwait, & Wetherwax, 2002).

Active learning spaces, sometimes called next generation learning spaces or computer-supported collaborative learning spaces, are educational facilities designed to promote social interaction and group learning. Key features of these classrooms are the de-emphasis of the “front” of the room, and the ability for students to face each other in small groups in order to facilitate group collaboration and discussion. Both staff and students are observed to behave differently in active classrooms compared with traditional classrooms. Staff are less likely to lecture and more likely to promote discussion when in an active classroom (Whiteside, Brooks, & Walker, 2010). Students who learn in active learning spaces report greater interactivity and better group collaboration (Wilson & Randall, 2012), and outperform academic expectations (Brooks, 2011) compared with students taught in a traditional setting.

Chism (2006) described spaces that are harmonious with learning theory and the needs of current students as being: flexible, comfortable, stimulating to the senses, decentred and supported by technology. In particular, settings that encourage interpersonal activity and are supported by technology lead to higher student engagement (Hunley & Schaller, 2006; Villano, 2010; Whiteside et al., 2010) and group interaction while using technology has been shown to have a greater effect on learning than using technology alone (Liao, 2007; Lou, Abrami, & d'Apollonia, 2001). While it is

generally agreed that technology should be ubiquitous in active learning space design, it is less clear what configurations of computing hardware best support and promote desired learner characteristics in these spaces.

The University of Western Australia has an active learning facility, built in 2013 for undergraduate students studying biomedical science subjects. Learner workstations are arranged in groups of 6 and fitted with wall-mounted LCD screens. A unique feature of the facility is that the room is partially fitted with laptops on the desks in a one computer per student configuration and partly with wireless keyboards and mice to be shared among students. This allows a direct comparison of the two configurations within the same cohort of students and program of study. Students were given free access to both configurations during class time and encouraged to try both settings. Staff and students were asked to nominate their preferred configuration via anonymous surveys.

## Methods

### Facility

This study was conducted in an active learning facility (the M Block e suites), constructed at the University of Western Australia in 2013 for the education of students studying Biomedical Sciences subjects. The facility had a total capacity of 174 students, arranged with 6 students at each of 29 tables. Each table was fitted with 2 in-built Mac Minis operated by wireless keyboards and mice, power outlets, network points, A/V input ports and 2 wall-mounted LCD screens. The facility was also fitted with high capacity WiFi access.

Within the facility, two table configurations were used (Figure 1). Laptops were installed on 18 of the desks (one computer per student configuration) so each student had access to their own screen and controls. On the remaining 11 tables, students had only the Mac Minis (shared configuration) so a group of 6 students needed to share the 2 keyboard and mouse pairs available.



**Figure 1: Photograph depicting the two computer configurations present in the M block e suites active learning facility**

- A. One computer per student configuration, where each student is supplied with a laptop.**
- B. Shared configuration, where groups of 6 students have shared access to wireless keyboards and mice that operate 2 computers installed inside the desks.**

In the first week of semester when students were introduced to the new facility the two different configurations were explained and students were given the freedom to choose where they preferred to work. They were encouraged to try both configurations and informed that they would be surveyed as to their preferences.

### **Participants and unit design**

Ethics approval was granted by the University of Western Australia Human Research Ethics Committee to conduct anonymous surveys of staff and students.

This study was conducted in a second year Pathology unit called *Introduction to Human Disease*, with 310 students enrolled. One tutorial of 2 hours duration was held in the M block e suites learning facility each week for half the class and repeated the following day for the other half. Students were given case-based problems to work on in groups, then assessed individually at a later time via an online quiz. The learning outcomes of the tutorial activities were based on interpretation of pathology test results. The cases and related problems were written by teachers from the faculty. Each teacher was responsible for one or at most two tutorials. All materials were made available to students online and attendance rates ranged from 70 to 90% (mean +/- SD 81 +/- 8%) in the first 6 weeks of semester.

### **Survey methods**

Students were offered two anonymous online surveys via the unit LMS page (*Moodle*), one during weeks 5 and 6 of the semester and another in weeks 12 and 13. In order to ensure that duplicate responses were not used in the analysis (responses mid-semester and at the end of semester from the same student) only the mid-semester survey was used for this analysis. The survey covered a range of topics, including student opinions on the tutorial and lecture topics given, the experience in the e-suites, perceptions of the computing configurations and overall perceptions of the unit. The questions comprised a combination of radio button graded questions and free text comments. A total of 93 responses out of 310 students enrolled were received (30%).

Teachers were invited via email after the semester to participate in an anonymous survey (*Google Forms*). Of 11 teachers invited to contribute, 8 responses were received (73%).

Both the student and teacher surveys are provided in full in Appendix A.

## **Results**

### **Preferences for number of computers per table**

Students given free access to two configurations of computing facilities, the shared configuration and the one computer per student configuration, were asked to indicate their preference via anonymous survey (Figure 2). Of 93 responses received, 46 students opted for one computer per student and 47 for the shared configuration.

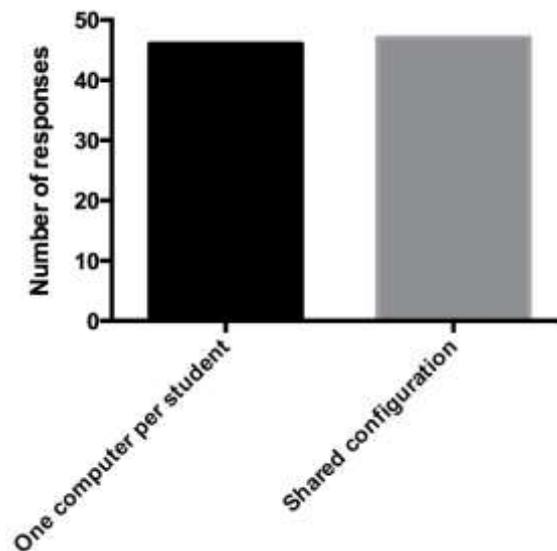
Students were further asked to select the optimal number of computers for a table of 6 students (Figure 3). 45% of students opted for 6 (one computer per student) and 55% opted for a number fewer than 6, with 3 being the most common choice among students who chose the shared configuration.

Two teachers (25%) indicated that they preferred where students shared computers, six (75%) said they did not notice a difference and no staff reported preferring one computer per student (0%). The mean optimal number of computers suggested by teachers was 3.4.

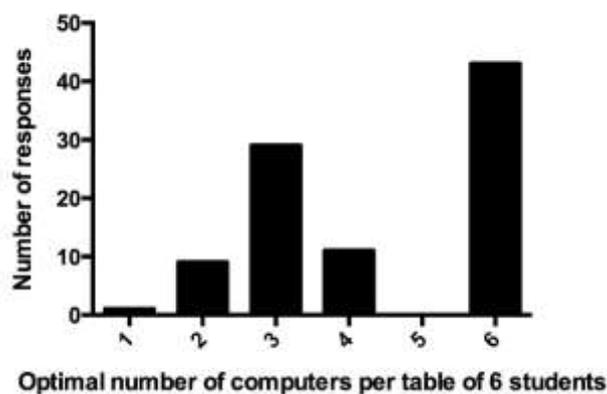
### **The learning facility, and the shared configuration in particular, promote group work**

Word analysis was performed on 56 student responses to the statement “The best thing about the M Block e suites is...” (Figure 4). The word “group” was the most frequently used word, along with other group-oriented words such as “share,” “everyone” and “together.” The emergence of such words

indicates that students associated the facility with group interaction. Improved group interaction was also identified by teachers, with seven (88%) agreeing with the statement “Students worked as a group better in the e suites than in other environments” (Figure 5).



**Figure 2: Student preference for computer configuration in the active learning facility**  
 Students were asked to select from “I prefer everyone having their own computer to work on individually” (one computer per student) or “I prefer fewer computers so students work together” (shared configuration)



**Figure 3: Student responses to the statement “The optimal number of computers per table of 6 students is...”**

Of 93 respondents to the student survey, 70 provided free text comments and of those 8 students directly discussed the different computer configurations in the e suites. One student praised the presence of different configurations, as having the two configurations offered students choice. The comments favouring one computer per student ( $n = 3$ ) and the shared configuration ( $n = 4$ ) are presented in Table 1.

Comments favouring one computer per student tended to emphasise speed, in particular that sharing computers is slower than each student having their own, and that sharing leads to a negative student experience. Comments that favoured the shared configuration mentioned communication, engagement and group work, suggesting that the latter promotes these qualities in the learning environment.



**Table 1: Student comments comparing the one computer per student to the shared configuration**  
**Students were not explicitly asked to compare the configurations, these comments were received in response to the questions “The best thing about the M block e suites is...” and “Do you have any further comments to add?”**

Comments favouring one computer per student	Comments favouring the shared configuration
<p>“Definitely not the iPad section sorry guys, also not when people harass us about using more than two computers at a time - we work at a pace together and ask questions and discuss together when needed. Less computers slows us down.”</p> <p>“There needs to be reinforcement of group work but not through only letting us use two computers. This has a negative effect on the overall progress.”</p> <p>“For the e-suites there are times when the demonstrator asks the students to only use 2 computers. This is a bad idea. This leads to the other 4 students out of 6 to work in pace with the 2 having the computers.”</p>	<p>“The iPad room [is best]. In the other lab it can be similar to a normal computer lab environment (in regards to communication), but it really depends on the group you are with.”</p> <p>“working in group to solve problems using common desktop that way i am more engaged in the activity.”</p> <p>“When we are required to share the computer screen, we are forced to communicate and discuss with one another which is amazing and a great way for us to learn. having individual desktops tend to result in each person doing their own work.”</p> <p>“The experience of working as a group. It works better when there isn't 01 computer per student.”</p>

## Discussion

Students were divided on whether they preferred one computer each or shared computing facilities. Students who preferred to share computers gave reasons of better communication, greater engagement and more effective group work. These results suggest that a desk configuration with fewer computers per student may provide an environment that promotes group learning.

Our student cohort had mixed opinions regarding sharing computer terminals. Previous studies have shown that not all students immediately embrace group work (Davies, 2009; Oliveira & Sadler, 2008), despite extensive evidence that group work leads to better learning outcomes (Johnson & Johnson, 2009). Where sharing of computers has been investigated specifically, task achievement as a group and as individuals is higher (Liao, 2007), and students persevere more when working as a group with a single computer than when working on computers individually (Lou et al., 2001). These same authors pointed out that when students work on individual computers they complete tasks faster, an observation also noted by students in the present study. However, clearly fast completion of an exercise does not equate to better learning. Indeed none of the students who stated a preference for the one computer per student configuration cited learning benefits as the reason. This study was limited to perceptions and did not attempt to track student grades as a result of environment, but through promotion of group work it is possible that the shared configuration also promotes greater student achievement.

A further benefit of the shared configuration used in this study was a cost saving with the use of fewer computers (saving six laptops per table or approximately \$500 per student). The minimum components required to create desks suitable for group work (two computers connected to two shared screens) can be implemented relatively cheaply as they do not require a sophisticated A/V switching system such as is present in our classroom. The cheaper shared configuration may be suitable for institutions hoping to create a technology-rich collaborative environment on a budget.

When asked what was the preferred number of computers per table of six students, 45% of respondents chose 6 (one computer per student) and 55% selected a number smaller than 6. Interestingly, more students selected 3 or 4 computers as being optimum and only 10% chose 2, the number of computers supplied in the shared configuration. The desks fitted in the active classroom had numerous power outlets, network points and A/V screens that allowed students to connect to the in-built desks, and students were permitted to bring their own portable computing devices to class. Therefore, although only 2 computers were supplied per shared configuration desk, students may have been using their own devices to approach what they considered to be the optimum number of 3 or 4 computers per desk.

One limitation of this study is that students were allowed to choose which configuration they used the most. It is possible that those students who preferred group work prior to the semester chose to sit in the configuration that favoured this type of interaction and that those students focused on completing class activities quickly chose the individual configuration. Although students were encouraged to try both configurations, this was not enforced. However, our results are consistent with previous studies on the impact of shared computing that have shown increased group interaction with shared access to technology (Liao, 2007; Lou et al., 2001).

This study was not designed to measure the learning gains associated with sharing computers, nor was effective group work an explicit outcome of the course. Furthermore, we cannot overlook the possibility that students may be feeling engaged when they can see a shared screen but that their learning gains may not be as great. These areas are worth pursuing in further research. Our results give an insight into student preferences for computing configurations (shared or individual) and their reasons for those choices. Future studies should use randomised controlled methodologies to establish whether learning gains are dependent on the computing configuration, and whether those gains are true for all students or only those students who are using their preferred configuration. It would also be interesting to explore whether student group performance is influenced by configuration and preference for shared facilities. The present study provides pilot and baseline data which can be built upon in future work.

In this particular unit, the activities (mostly case-based interpretation of scientific tests) have been designed specifically for group learning. The effect of environment on student group cohesion is dependent on the type of activity conducted (Hunley & Schaller, 2006) and on group composition (Oliveira & Sadler, 2008). Teachers wanting to adopt a similar approach are advised to consider the suitability of their teaching activities for group learning. However, for those who are looking to support group activities with technology the findings of this study suggest that fewer computers may better promote interaction between group members than one computer for every student.

## **Conclusion**

This study explored student opinions of two possible computer configurations in an active learning facility and found that having fewer computers installed per student encouraged and fostered group interaction between students, in addition to saving money on computer terminals. These results may be of interest to universities or schools who want to design educational facilities to promote group learning.

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## Appendix A: Student survey

(Weeks 5 and 6 of semester: How are things so far?)

Hi students,

We are very interested in your feedback on a range of things we have used in this unit, especially seeing as this unit is being run for the first time. We would greatly appreciate if you can find the time to fill out this anonymous survey regarding your experience this semester.

The survey contains 24 questions and should not take more than 20 minutes to complete.

Important information:

This survey is ANONYMOUS. Although we will see your written answers, they will not be linked to your name and comments you make in this survey will not affect your marks in any way.

This survey is OPTIONAL. You do not need to complete it and if you choose not to complete the survey it will not impact your marks.

If you have any concerns regarding the survey, please contact A/Prof Kimberley Roehrig on [kimberley.roehrig@uwa.edu.au](mailto:kimberley.roehrig@uwa.edu.au) or raise the issue with your student representative.

Cheers,

Kimberley.

*Approval to conduct this research has been provided by The University of Western Australia, in accordance with its ethics review and approval procedures. Any person considering participation in this research project, or agreeing to participate, may raise any questions or issues with the researchers at any time.*

*In addition, any person not satisfied with the response of researchers may raise ethics issues or concerns, and may make any complaints about this research project by contacting the Human Research Ethics Office at The University of Western Australia on (08) 6488 3703 or by emailing to [hreo-research@uwa.edu.au](mailto:hreo-research@uwa.edu.au)*

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(\*)Answers are required to starred questions.

I am\*

- a Pathology and Laboratory Medicine major (degree-specific or second major)
- a Biomedical Science major an exchange student
- I haven't decided yet
- Other

The questions in this first section relate to your lectures.

The pace of the lecture material in this unit is:

- Too fast
- About right
- Too slow

This unit has

- Too many lectures
- About the right amount
- Too few lectures

The lectures in this unit are presented in a logical sequence

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

I look forward to watching lectures in this unit

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

Do you wish to add any further comments about lectures in this unit?

The questions in this next section relate to your ePracticals.

I find the ePracticals in this unit

- Too difficult
- About right
- Too easy

This unit has

- Too many ePracticals
- About the right amount
- Too few ePracticals

The number of demonstrators available in each ePractical is

- Too many demonstrators
- About the right amount
- Too few demonstrators

The ePracticals in this unit are a good way to learn the required material

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

The material presented in the ePracticals is engaging and interesting

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

I look forward to participating in ePracticals in this unit

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

Do you wish to add any further comments about the ePracticals in this unit?

The questions in this next section relate to the M Block e learning suites.

The environment in the e learning suites is suitable for learning this material

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

When working as part of a group, I feel I

- Learn more
- Learn less

I think I learn more in classes in the M Block e learning suites than I would in a conventional computer laboratory

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

The best thing about the M Block e learning suites is:

I prefer:

- Everyone having their own computer to work on individually
- Fewer computers so students work together

The optimal number of computers per table of 6 students is:

- 1
- 2
- 3
- 4
- 5
- 6

The questions in the final section relate to the unit overall.

I would recommend this unit to first year students

- Yes
- No

In this unit I have already gained an understanding of the pathological basis of disease

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

How does PATH2201 rate compared with other units you have taken or are taking in 2013? (First = the unit you like most, Last = the unit you like the least)

- First
- Second or third
- Fourth or fifth
- Sixth or seventh
- Last or close to last

The knowledge I have gained has altered my thinking about my future choice of units

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

Do you have any further comments to add, about the e suites or about your classes, or about PATH2201 in general?

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## Appendix B: Teacher survey, end of semester after exams

Dear colleagues,

We are interested in your feedback on teaching in which you participated in 2013. We would greatly appreciate if you can find the time to fill out this anonymous survey.

The survey contains 18 questions and should not take more than 15 minutes to complete.

Important information:

This survey is ANONYMOUS. Although we will see your answers, they will not be linked to your identity in any way.

This survey is OPTIONAL. You do not need to complete it and if you choose not to complete the survey it will not impact you.

If you have any concerns regarding the survey, please contact A/Prof Kimberley Roehrig on [kimberley.roehrig@uwa.edu.au](mailto:kimberley.roehrig@uwa.edu.au).

Anonymous comments can be made via a staff representative.

Cheers,

Kimberley.

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Did you teach in the unit PATH2201 in 2013?

- Yes
- No

### Teaching facilities

Please rate the quality of the teaching facilities for LECTURES in this unit

1 2 3 4 5 6 7 8 9 10

Poor quality facilities           Very high quality, state of the art

Please rate the quality of the teaching facilities for TUTORIALS in this unit

1 2 3 4 5 6 7 8 9 10

Poor quality facilities           Very high quality, state of the art

How did you find teaching in the e suites?

- Better than average classrooms I've taught in previously
- About the same as classrooms I've taught in previously
- Worse than average classrooms I've taught in previously

In what ways did teaching in the e suites differ from other small group teaching environments (for example wet labs or bottle tutorials)?

Select all that apply

- Students worked as a group better in the e suites than in other environments
- Students were more productive in the e suites than in other environments
- Students learned more in the e suites than in other environments
- Students finished their work faster in the e suites than in other environments
- Students were more focussed in the e suites than in other environments
- Students were more engaged in the e suites than in other environments
- Other: \_\_\_\_\_

How many demonstrators do you think are optimal in this venue for a class of approximately 150 students?

- Teacher alone
- Teacher plus 1 or 2 demonstrators
- Teacher plus 3 or 4 demonstrators
- Teacher plus 5 or 6 demonstrators
- Teacher plus more than 6 demonstrators

Do you have any further comments to add generally about the e suites?

#### Desk configurations

Some of the desks within the e suites have laptops on them (in the red and green rooms) while others do not (in the blue room). Did you notice a difference between these two configurations?

- I preferred every student having their own laptop
- I didn't notice a difference between the two configurations
- I preferred no laptops so students shared the computer screens

How many computers do you think is the optimal number for a group of six students?

- 1
- 2
- 3
- 4
- 5
- 6

Please comment on any differences you noticed between the areas with laptops and without

#### Developing material for PATH2201

Did you develop a teaching module (a tutorial) for PATH2201 in 2013? \*

- Yes
- No

Was the support you received for developing and delivering your tutorial helpful?

- Strongly disagree (not helpful at all)
- Disagree
- Neutral
- Agree
- Strongly agree (very helpful)

Would you do things differently next time?

- Yes, major changes
- Yes, minor changes
- No changes

What changes would you make (if any)?

Did you find the format (a worksheet and exercise in class in groups, followed by an online quiz) suitable for the topic you taught?

- Yes
- No

Please explain your answer or offer suggestions for improvement

Do you have any further comments to add about developing your tutorial for PATH2201?

### Final comments

Is there anything else you would like to add, about the survey or about teaching in PATH2201?

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