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Technology-enabled active learning environments: an appraisal
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Technology-enabled active learning environments: an appraisal

By Kenn Fisher, University of Melbourne, Australia

This article examines the emergence of technology-enabled active learning environments and the reasons for their appearance. It explores three case studies and considers how effective they are in enhancing teaching and learning outcomes.

The recent advent of wireless broadband Internet access and mobile communications devices has provided remarkable opportunities for 21st century blended learning models – simultaneous online and face-to-face – and seriously called into question the industrial-age traditional "egg crate classroom" model of teaching and learning. It has also enabled the emergence of a true synchronous/asynchronous and virtual/physical matrix of learning opportunities for which our existing built learning environment infrastructure is not well suited.[1]

In response to these developments, many innovative learning environments are being trialed. These include an increasing focus on the "third space" which supports social forms of student interaction. The important issue here, especially in universities, is that students can now learn off-campus on line.

Figure 1. **Blended learning matrix combining face-to-face physical and online learning**
Virtual and physical online learning, time dependent and time independent

	Synchronous	Asynchronous
Local	Face-to-face meeting places	Site-specific signage Exhibitions Installations White board
Remote	Telephone video conference Textmessages Shared cyberlinks	Internet Web Virtual studio "Google it"

Source: Mitchell, W. (2003).

1. Mitchell, W. (2003), "21st Century Learning Environments", presentation at a workshop on new learning environments at Queensland University of Technology in conjunction with K. Fisher.

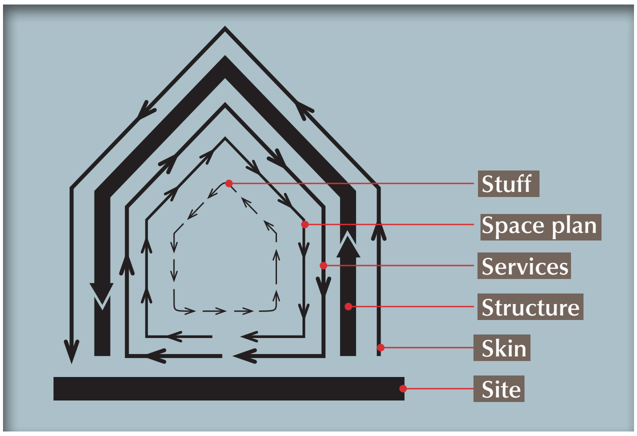
This is forcing us to rethink the nature of the 21st century campus, and more specifically what physical attributes need to be provided to encourage students to attend campuses and to actually meet face-to-face with their colleagues, rather than interacting through the now prevalent social networking tools. Interestingly, many of these spatial developments are being instigated – through initiatives lead by information technology and communications departments – particularly in universities and increasingly in further education and schools.[2]

LEARNING TECHNOLOGIES

The above developments are blurring the boundaries between what has traditionally been seen as the "built learning environment" and the information and communications technologies that support those spaces. The rapidly emerging models of "technology enhanced learning environments" (TEAL) – first introduced at MIT in 2003[3] – emphasises that acoustics, furniture, lighting (both natural and artificial), mobility, flexibility, air temperature and security must support the educational technologies being designed for those spaces. The traditional physical elements are technologies as well, but increasingly these are interdependent with ICTs and audio-visual educational technologies.

In my view, all of these elements should be integrated under the one heading of "learning technologies" and be considered within the same framework, whether it be budget, design, maintenance or flexibility. The key issue is that the life cycle of each element and how these vary must be attended to in such a way that all elements are up to date.[4] "Stuff", as Brand calls the moveable elements, includes technologies such as computers which tend to have a life cycle of 3 years. The space plan may well be 7 years, the services 10-20 years whilst the structure could be in excess of 100 years. We are, of course, finding that inserting these new technologies into existing buildings, and especially heritage buildings, is complex.

Figure 2. **Stewart Brand's hierarchy of core building elements**



Source: Brand, S. (1995), *How Buildings Learn: What Happens After They're Built*, p. 15.

2. See a) Higher Education Funding Council for England (HEFCE) on behalf of JISC (2006), "Designing Spaces for Effective Learning", *www.jisc.ac.uk/uploaded_documents/JISClearningspaces.pdf*; b) Education.au Limited (2009), "21st Century Leaning Spaces", *www.educationau.edu.au/learning-spaces*; c) Scottish Funding Council (2006), "Spaces for learning: a review of learning spaces in further and higher education", *www.jiscinfonet.ac.uk/Resources/external.../sfc-spaces-for-learning*.

3. Technology-enabled active learning (TEAL) is a teaching format that merges lectures, simulations and hands-on desktop experiments to create a rich collaborative learning experience; see *web.mit.edu/8.02t/www/802TEAL3D/teal_tour.htm*.

4. Brand, S. (1995), *How Buildings Learn: What Happens After They're Built*, Penguin.

LEARNING AND TEACHING

It is paramount that these new innovations align the physical space with the educational technologies so that both can support the pedagogies envisaged for those spaces. It is critical that this happen; after all, the traditional classroom had to evolve from simply meeting the didactive teaching methods which predominated prior to the emergence of significant educational technology.

I believe that the limitations of the traditional classroom in supporting these learning approaches is a cause of concern, whether they be in the form of lecture theatres and seminar/tutorial rooms in universities, or closed boxes for 25-35-40-45 students in schools (depending on the relevant country). The closed classroom represents a physically outdated teaching model which does not match the inter-connected virtual world we now live in. Students are learning collaboratively through a vast array of informal learning spaces both on and off campus, yet are still crammed into outdated traditional models. What we know as the "knowledge age" is rapidly morphing into a "creative age" yet classrooms, according to the students I have surveyed, are the least creative space they can learn in.

These learning spaces need to adapt to meet the emerging needs of a wide range of pedagogies. This concept is reflected in the Australian Learning and Teaching Council's[5] recent appointment of 15 discipline-specific teaching and learning advisors.

Although the original TEAL model noted above was launched to rejuvenate the teaching of Physics 1 at MIT, many versions of it have proliferated in geology, chemistry, engineering, education, architecture and some other disciplines. It is in engineering that the most advances have been made and this is largely because of the need for engineers to have a wide range of competencies than cannot be assessed solely in the examination room.

About the same time as TEAL, MIT's Aeronautical School initiated a new pedagogical model called CDIO (conceive, design, implement and operate). This approach has now taken off across the globe. Its wide use and variations in practice can be seen at *www.cdio.org*.

These issues are important because engineering schools are preparing students who, as professional engineers, will be required to work in self-directed ways through problem solving and collaborative team work.[6]

A critical notion to understand is the concept of graduate attributes or graduate competencies. For engineers, these might be expanded to include critical thinking, communicating to peers and the wider community, working in multi-disciplinary teams and environmental literacy. Engineers are involved in complex projects involving infrastructure which means they will have to work across – and in collaboration with – a range of disciplines. To continue to learn in a didactive, teacher-centred way will not provide students with those competencies.

5. See *http://www.altc.edu.au/april2009-altc-discipline-scholars-begin*.

6. Chang, R.L. *et al.*, "Places for learning engineering: A preliminary report on informal learning spaces", proceedings of the Research in Engineering Education Symposium 2009, Palm Cove, QLD, The University of Melbourne, Australia.

This was first understood in the teaching of medical students. For some 30 years medical students have been taught in a collaborative way with groups of ten students being supported by a tutor. This model is difficult to achieve across all disciplines because of budget constraints, but the approach can be modeled using the TEAL concept.

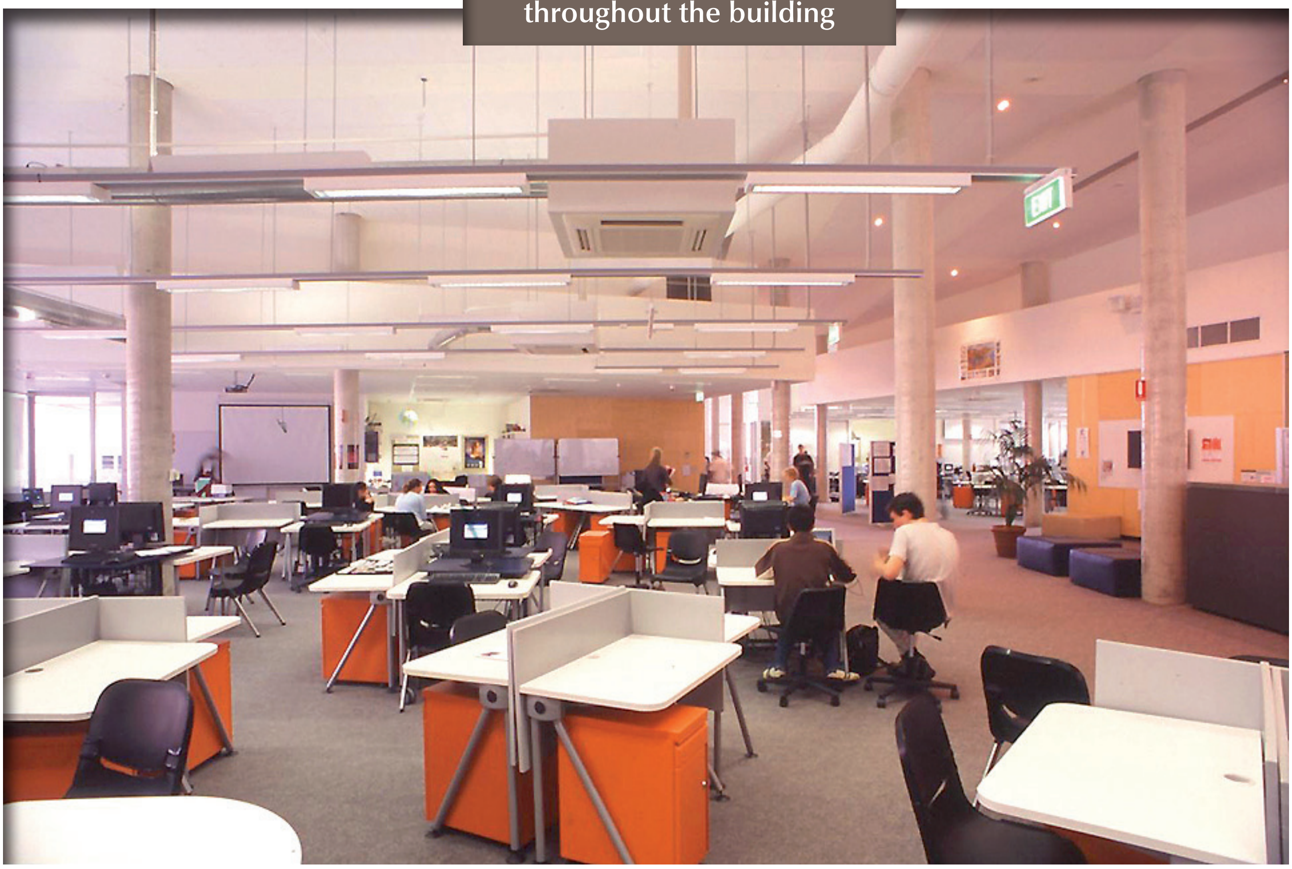
CASE STUDIES [7]

In order to illustrate how effective they are in enhancing teaching and learning outcomes, three case studies have been selected and are presented in chronological order, from 2003 to 2010.

The Australian Science and Mathematics School (ASMS) [8]

Opened in 2003, this public senior high school for pupils aged 15-18 (the final three years of secondary school) has been featured in many publications and received many international visitors because of its innovative design which meets what was then seen as a "radical" pedagogical approach. This school was planned around the CDIO concept before that concept became common knowledge.

View of Learning Commons showing transparency throughout the building



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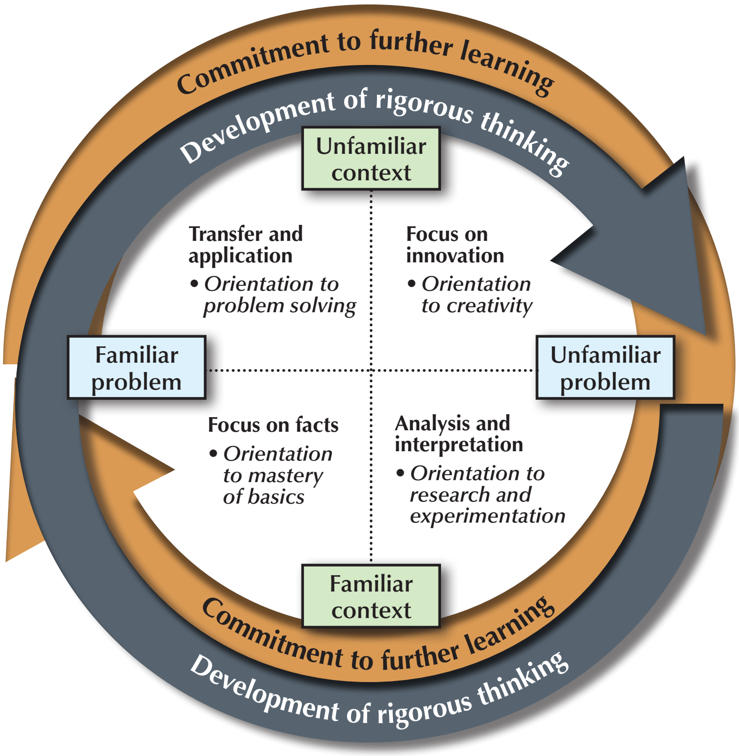
7. For further information, see *www.woodsbagot.com*.

8. Discussed in a previous issue of this newsletter; see *http://www.oecd.org/dataoecd/46/62/34276712.pdf*, pp. 24-26.

Figure 3. **A comparison of the stages of the Project of Scientific Enquiry with the ASMS model for deep learning**



Source: Oliver, G. (2007), "Scientific Inquiry Promotes Deep Learning", in "How do we meet the challenges of inspiring learners?", iNET online conference.

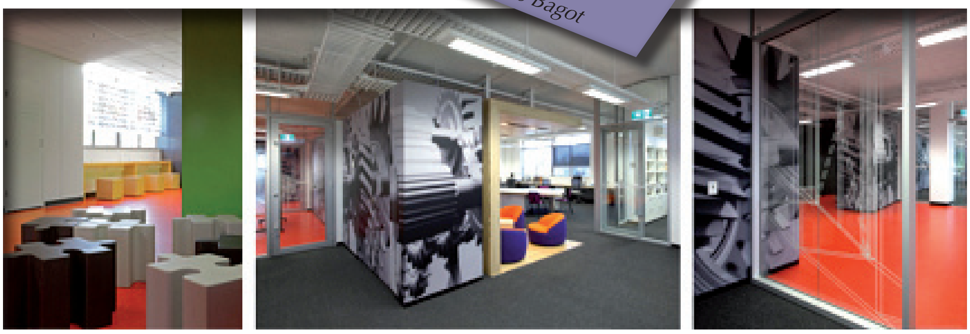
Key features of the school include:

- It focuses on problem-based learning around mathematics and science but also includes six other key learning areas.
- Learning principles include New Sciences, Inquiry Learning, Interdisciplinary Curriculum, Standards of Significance, Authentic Experience and Engagement and Retention.
- It is located on the campus of Flinders University in Adelaide.
- It designs and delivers the curriculum in partnership with the University's Faculty of Science.
- It acts as a professional development centre for national and international teachers.
- It consists of "learning commons" and "learning studios" collocated to foster seamless theoretical and practical learning.
- It enables students to organise desks in the learning commons to suit their daily agreed social and learning needs.
- Students host visitors and explain how the school works.
- It has been used as a model to "de-privatise" teaching practice through the transparent nature of the internal wall, most of it being glass.

4th Year and Doctoral Engineering Design Studio, the University of New South Wales

This facility, opened in April 2010, was designed for 100 4th year and 30 doctoral engineering students.

Figure 4. **3D view of the concept showing collaborative learning, research students, gallery space and café informal learning area**



The key elements of the studio are as follows:

- It offers integrated collaborative learning for undergraduates, postgraduates and partners in industry in research-led pedagogy where students work actively on projects with industry.
- It facilitates interaction between undergraduate, postgraduate and academic staff based on real-world design and research projects.
- It simulates the project-based type of environment students will face when entering industry.
- It comprises a studio, study spaces for 30 doctoral students, a gallery/foyer and functions space, café/kitchenette for social and other functions involving project partners from the world of industry.
- No fixed technology is used other than plasma screens at the perimeters: the technology used by students consists of state-of-the-art wireless and battery-powered devices eliminating the need for clumsy power and data connections which limit flexibility.
- It can accommodate 96 students in groups of 8; its 12 tables fold away to allow alternative uses for the space.

CDIO in the Faculty of Engineering, University of Melbourne

Conceive, design, implement and operate (CDIO) is the most recent version of collaborative learning spaces developed in the faculty. The CDIO concept allows students to work on theory and on practice seamlessly.

Faculty of Engineering, Learning Collaborative Classroom

© Woods Bagot

Key points include:

- It is designed for ten groups of six (60 students in all), with each group of six able to work in twos or threes.
- It allows students to work collaboratively on project-based activities in three-hour sessions. Not all students use the practical studio or laboratory at the same time, but they work on specific set projects in small groups.
- Social spaces and reflective spaces surround the studios for informal and collaborative study.
- It is used by the Faculty of Architecture, Building and Planning for construction students.
- Students now feel part of a community of learners and are observed within the Faculty for greater periods of time on campus, including weekends and evenings

EVALUATION OF TEAL

These emerging TEAL models which proliferated since MIT first launched the concept in 2003 are in the early stages of evaluation. Some publically available articles on evaluation show that these spaces work well. Although it is difficult to argue that the physical learning environment by itself can enhance teaching and learning, it is clear that the physical learning environment can inhibit the practice of some forms of effective pedagogy and therefore limit the extent to which graduate competencies can be delivered to students.

For example, on average 90% of ASMS's students go on to university, and yet it has no classrooms. However, another equivalent but independent senior secondary school, which only has classrooms and uses a tutor model (but with equally motivated teachers and students) also results in 90% entry to university. The key question, still to be researched, is whether these respective students are successful at the end of the first year and can then move effectively through the university system. Specifically, is the TEAL approach more effective in creating life-long learners compared to the 19th century traditional classroom model?

Some studies suggest that there are significant improvements to learning outcomes in adopting this approach.

> *Overall, these Active Learning Classrooms yielded very positive responses from instructors and students. The instructors who were interviewed enjoyed teaching in the rooms so much that their only concern was a fear of not being able to continue to teach in these new learning spaces. Similarly, more than 85% of students recommended the Active Learning Classrooms for other classes. Instructors and students overwhelmingly found that this space made a difference for them. "I love this space! It makes me feel appreciated as a student, and I feel intellectually invigorated when I work and learn in it.*[9]
>
> *The studio space is also a significant investment and so must clearly improve learning outcomes: engagement, attitude and collaboration in addition to absorption of the curriculum. Measures of those outcomes are necessarily qualitative at this point, but based on comments from student and faculty who actually learned and taught in the space, we would cautiously say that the studio has met those goals. Of course we will need to continue to evaluate progress in outcomes as people gain experience with using the space.*[10]

In evaluating teachers' learning at the ASMS, a recent doctoral graduate found significant connections between the pedagogical process and the flexibility of the ASMS school design.[11] Clearly, evaluation of the TEAL approach involves both quantitative and qualitative examination. It is also evident that qualitative studies show significant support for the TEAL model from both teachers and students. Further quantitative study is required to support these qualitative findings and this work is currently underway at the University of Melbourne's LEARN centre.[12] Findings will be made available as they become public.

What is most pleasing from my viewpoint is that there are exciting alternatives emerging to the traditional closed classroom and these are gaining increasing acceptance. I certainly look forward to evaluating and using these findings in future projects and research.

For more information, contact:
Dr. Kenn Fisher
Associate Professor Learning Environments
Faculty of Architecture, Building & Planning
Learning Environments (Action) Research Network
University of Melbourne
Parkville, Victoria
Australia
Tel.: +61424022039
E-mail: fisherk@unimelb.edu.au

9. Alexander, D. *et al.* (2009), "Active Learning Classrooms Pilot Evaluation: Fall 2007 Findings and Recommendations", The University of Minnesota, *www.classroom.umn.edu/projects/ALC_Report_Final.pdf.*

10. Tom, J., K. Voss and C. Scheetz (2008), "The Space is the Message: First Assessment of a Learning Studio", *www.educause.edu/EDUCAUSE+Quarterly/EDUCAUSEQuarterlyMagazineVolum/TheSpaceIstheMessageFirstAsses/162874.*

11. Bissaker, K. (2009), "The processes and outcomes of professional learning in an innovative school: the construction of an explanatory model", unpublished thesis.

12. The Learning Environments Action Research Network is associated with the Smart Green Schools project; see *www.abp.unimelb.edu.au/research/funded/smart-green-schools.*

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