# DOING ON LINE LEARNING AND TEACHING

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## SUMMARY

We review experience over ten years of using computer mediated learning in key aspects of form-making, and more recently construction and decision making processes in the built environment in architectural education. This has been a typical process of reflective practice (Schon, 1983), where designing and running classes, and monitoring results, has informed the gradual development of approaches that seem to work. The paper concentrates on extensive formal evaluations of how students respond to the learning experience. The recurring theme is finding and exploiting synergies between the characteristics of digital media and effective means of reinforcing learning objectives, where sources are found in both the architectural and the education literature. There are issues of familiarity, cultural change, differences in digital and manual representations and the consequent ease of "making what I'm thinking" for a student, and the development of confidence in architectural and media concepts.

## COMPUTERS IN ARCHITECTURE SCHOOLS – A BRIEF HISTORY

As in most fields, 'doing' on-line learning and teaching is an important part of gaining insight and developing techniques. In this paper we shall begin with a brief history, describe our own experience in form-making, CAD and online learning, and then report extensive formal evaluations that we have carried out in recent years on how students respond to the learning experience.

By way of context when describing developments in computer systems and their use, 25 years ago one flew from England to Australia in a Boeing 747–we still do. The shape has not changed much, but the computer technology that assists pilots in flight has changed enormously. It is this rapid development of the underlying technology rather than educational forces that has driven change in both digital making and teaching using computers.

In 1975 a few pioneering researchers and postgraduates wrote computer programs for mathematical modelling of processes relevant to architecture: structures, heat flow, daylight factors, financial models. By 1980 computers were 'known' to be 'important', and there were courses in undergraduate programs called something like 'Computers in Architecture' in which academics tried to find something useful to teach. Typically such a course would include some 'how computers worked', some 'BASIC' programming, and some rudimentary graphics. While the process of learning may have benefited students, any value in the specific skills learnt had an embarrassingly short life. By 1985 there were CAD systems, good drawing graphics programs and Macintosh computers, and drawing formed the basis of computer courses. A small proportion of students began to use CAD in design studios. By 1990 the tables were turned, in that instead of form-making being the vehicle for teaching about computers, the computers had began to be a vehicle for teaching about form-making. By 1995 this was becoming mainstream in some schools. But only within the last five years has the position of the computer shifted from being a tool to be used to carry out specific tasks and produce images for a class, to being the environment within which much of the class takes place. Work is described, set, submitted and assessed in digital form. Further, the role of computers has broken out of the arena of specific 'computer' courses to become an environment for other mainstream core and elective courses. In 2001 74% of Adelaide's new intake of first year students had access to the Internet at home. It is now realistic - although not necessarily desirable - to offer a largely on-line off-campus architecture program. Looking ahead five years, we might expect most students to have access to their own personal computers with accessories such as digital cameras, fast networks, large improvements in the software available, and excellent third-party courseware. But prediction is notorious. We are far from a stable situation.

Over these years, the development of teaching strategies has been a process of 'reflective practice' (Schon, 1983), learning from experience and student practice in re-designing programs for another academic year. This process of refinement has been overlaid and complicated, and sometimes dominated, by the enlargement of possibilities through hardware and software developments. This enlargement of possibilities has also occurred through the increasing proportion of academic staff who feel 'comfortable' using computers, as well as the developing level of knowledge new students bring.

## COURSES WITH ON-LINE LEARNING

We shall describe three domains in which on-line learning has been employed in Adelaide. In the earlier years (prior to 1998) this learning was a component of conventionally-organised courses, where the use of a computer essentially provided the learning medium for that segment. In the later (last 4) years, an increasing proportion of courses have been organised in online frameworks, with all course material available on the course web site and mostly electronic submission of student work. All of these have provision for 'bulletin board' and class email, although teachers vary in the degree to which they make use of this means of communication. Until recently, we wrote and maintained the software to deliver our courses. This created a deal of flexibility, but frustrated the scope of our ambitions. Adelaide University has recently standardised on Blackboard as a platform for on-line courseware, which removes flexibility but provides a stable platform for those aspects it supports.

### CAD and Form Making

We first began using computer graphics and modelling as a means for architecture students to learn about form and composition in 1989, using an approach developed with Professor Robert Oxman and Dr. Rivka Oxman of the Technion, Israel, in which students progressed rapidly through a series of highly structured 'exercises' on the making of building plans, following themes such as order, composition, enclosure and precedent. The work (originally in Sydney University) and the theory around it resulted in a publication, *The Language of Architectural Plans,* (Oxman, Radford and Oxman, 1987) and a number of papers. Since that time we have continued to build on those ideas and taken them in various directions, including more emphasis on 3D form and composition rather than plans. The kinds of 'exercises' (which they developed) we have more productively re-framed as 'games', developing and exploiting the nature of play as a way of learning.

Many of these exercises (or games) could also be carried out by hand. The digital medium, however, facilitated design moves such as scaling, symmetry, and repetition with variations. It also provided a relatively 'safe' environment where mistakes could be corrected, experiments undone, and multiple copies kept (the 'relatively' is because catastrophic instances occur where students 'lose' all their work). From the early days we encouraged a comparison of digital and manual media.

By teaching basic design concepts in parallel with teaching understanding of concepts and skills in CAD, both aims are advanced. Architectural education has long relied on students developing drawing and modelling skills in design studios, so this might be expected. The difference is the way in which specific design skills are matched with specific CAD skills in the class. Over the years there has been an increasing structuring of the student assignments to ensure this mapping, and the first year, first semester CAD class has developed a close link with a first year, first semester basic design class. One of the lessons has been the need in these assignments to provide sufficient structure to ensure the learning goals are met, while still being open ended enough for the most adventurous and capable students to maintain interest and demonstrate their abilities.

### CAD and Construction

One of the on-line courses in 2001 was a construction class that included two highly structured assignments framed as games. One of these involved the design and building, as a detailed 3D computer model, of a small timber-framed bicycle shed to 'fit' in the garden of an existing award-winning house (http://www.arch.adelaide.edu.au/games/bikeshed/index.html). The other involved the design of the construction for a new external door to fit in a wall of the same house (http://www.arch.adelaide.edu.au/games/holeinwall/index.html). To make a convincing construction model a student needs to know many of the 'rules' of construction, and it is relatively easy for an assessor to 'explore' a model to check that all the required components are present and organised to make a coherent design. As we shall see in the following section, though, modelling at this level is

only enjoyable if the student has previously mastered the skills, and modelling is time consuming so that a student discovering a significant error is faced with a major task in re-creating the model. This was countered by asking students to simply note such errors and describe in writing what needs to be changed rather than make the changes, but any such discovery reduces student pride and satisfaction with the results. The same would apply to a physical 3D model. In the case of this class, the 'door' was a very limited task and most students succeeded with little pain, whereas the 'shed' was more demanding and some students had great difficulty. On the other hand, students probably learnt more from the 'shed' game, including as it did, all the components of timber-framed construction.

**Decision Making Processes Concerning Issues in the Built Environment**

'Built Environments' is a first year, first semester course addressing the nature of design for the built environment across a spectrum of architecture, landscape architecture and urban design. It includes components of information-finding, problem-framing and design. The course was delivered online through Blackboard, and the three assignments were digital. For the first, "e-research", students explored an issue in the local built environment through a Bulletin Board group. In the second assignment students researched stakeholders' points of view in divisive development issues through "e-role play" within a Bulletin Board environment. In the third they designed a bird hide for the Banrock Station wetland beside the South Australian Murray River, utilising their newly acquired form•Z skills ("e-design") or, alternatively, manual design and model making.

## WHICH DIGITAL APPROACHES WORK?

Until 1999 feedback from students about their experience in these classes consisted of anonymous responses to questionnaires about the class as a whole and informal personal contact between class teachers and students. The School routinely surveys student perceptions of all its courses. Two national CUTSD (Committee for University Teaching and Staff Development) funded projects focusing on the framing of learning situations as 'games' in an on-line environment have enabled us to carry out detailed analyses in the last three years. While student perceptions are not the only indicator of effectiveness, there is research evidence that deep learning is associated with an expectation of enjoyment. Feedback from students that reports difficulties experienced must be taken very seriously.

**Conducting evaluations of on-line learning**

The longitudinal case studies which are reported here were conducted in the Adelaide University School of Architecture, Landscape Architecture and Urban Design in 1999, 2000, and 2001 in CAD 1 (Level 1), Design and Form 1B (D&F1)(Level 1), digital components of Australian House Construction Levels 2 and 3 (HC2/3)(Level 2 and 3), and Built Environments 1(BE1)(Level 1). By 2001 CAD1, Design and Form 1, Built Environments 1 and Housing Construction 2/3 were also partly *delivered* online.

The "integrated" evaluations of case study courses were conducted with the following instruments:

- (**formative**) IT Skills Surveys at enrolment conducted by the academic registrar;
- (**summative**) Student Evaluation of Teaching (SET) administered at the conclusion of teaching;
- ("**illuminative**") ethnographic in-classroom participant-observations, document review and analysis and interviews conducted by a professional evaluator throughout the course teaching;
- (**quality assurance**) review of web sites, robustness of digital models and on-line delivery conducted by the School e-learning manager (Oliver, 2000).

## EVALUATION OUTCOMES

We have selected the "Seven Principles for Good Practice in Undergraduate Education" (Chickering and Gamson, 1987), reworked as the "Seven Principles of Effective Teaching: A Practical Lens for Evaluating Online Courses" (Graham, et al. 2001), as a focused framework for reporting online learning. These are listed in Table 1. We emphasise that space limitations demand that extensive qualitative and quantitative research data be summarised into bullet points and discussion. We refer to our recent (Woodbury et al., 2001, Woodbury et al., 2000) and forthcoming publications (Shannon et al., 2001, Shannon and Roberts, 2001) for detailed research data.

| Principle | Lesson for online instruction |
|---|---|
| "Seven Principles for Good Practice in Undergraduate Education" (Chickering and Gamson, 1987) | "Seven Principles for Effective Teaching: A Practical Lens for Evaluating Online Courses" (Graham et al. 2001) |
| 1. Good Practice Encourages Student-Faculty Contact | 1. Instructors should provide clear guidelines for interaction with students |
| 2. Good Practice Encourages Cooperation Among Students | 2. Well designed discussion assignments facilitate meaningful cooperation among students |
| 3. Good Practice Encourages Active Learning | 3. Students should present course projects |
| 4. Good Practice Gives Prompt Feedback | 4. Instructors need to provide two types of feedback: information feedback and acknowledgement feedback |
| 5. Good practice emphasises time on task | 6. Online courses need deadlines |
| 6. Good Practice Communicates High Expectations | 6. Challenging tasks, sample cases, and praise for quality work communicate high expectations |
| 7. Good Practice respects diverse talents and ways of Learning | 7. Allowing students to choose project topics incorporates diverse views into online courses |

**Table 1** Successful undergraduate pedagogies and their online counterparts

The underlying point we stress in fore-fronting this framework for reporting evaluation outcomes is that *learning* comes before *online learning.* Students, and rightly so, do not separate content from delivery context in understanding and evaluating their own learning. *How* they learn, and *what* they learn are inextricably linked in their approach to learning. We respect that "The Medium is the Massage" (McLuhan and Fiore, 1967). We tested the theory that content and context are linked in students' Semester 1 Student Evaluation of Teaching responses for the 2001 courses Built Environments 1 and Computer Aided Design 1. Table 2 illustrates that the same cohort of students will differentiate on the course content and presentation where the delivery *context (*Blackboard interface) remains constant.

| Course 9091 | Course 4168 | SET Question |
|---|---|---|
| 61.4 | 94.5 | 1. Course materials were affectively presented on the Website |
| 66.1 | 87.7 | 2. Completing tasks was aided by the online resources |
| 82.3 | 72.7 | 3. The vGallery was a good tool for submitting work |
| 32.2 | 57.6 | 4. Feedback on my work on the vGallery was useful to my learning |
| 79.1 | 57.6 | 5. I used the vGallery to learn what other students were doing |
| 51.6 | 74 | 6. Independent learning was helped through the online course experience |
| 66.1 | 76.8 | 7. My knowledge of the subject was enhanced through the online material |
| 32.2 | 75.3 | 8. The bulletin board was useful to my learning |

**Table 2** Comparison of student SET responses showing % of students who 'agree' or 'strongly agree' with the proposition (Likert scale 5-7). For course 9091 (CAD1) there were 102 students and 62 responses ( 60.8%). For course 4168 (BE1) there were 98 students and 73 responses (74.5%)

**Instructors should provide clear guidelines for interaction with students**

The evaluation findings reinforce a preliminary view (Woodbury et al., 2001) that in order to encourage digital competence, confidence in the new media is a necessity. This competence arises from long hours of time on task, and from a confidence in the efficacy of this time investment generated partially from the student's perception that there are clear guidelines and standards for what is to be learned.
Whereas a student's learning style (Kolb, 1976) is thought to be 'fixed for life', there is substantial recent research evidence that a student's approach to learning (ie deep, surface, strategic or disintegrated) (Prosser and Trigwell, 1999) is deeply influenced by previous encounters with similar learning contexts. Previous perceived success strongly tempers new encounters. Seen this way, 'mathematics hate', for example, might be more a function of previous frustration than present capability. In our context, prior deep learning bootstraps present deep learning, the elements of which are an intersection of motivational context, learner activity, interactive context, peer interaction,

ownership (of learning, and outcomes) and embedded teaching (Biggs, 1999). All of these put a premium on building student confidence through solid support, especially by providing clear guidelines and standards for what is to be learned; a perception that the teaching is well organised, with timely and useful feedback (James and McInnis, 2001), and the confidence this context inspires.

Conversely, a learning context that is perceived as providing an overwhelming amount of content to memorise for assessment is often associated with the adoption of a *surface* approach to learning. The disability of this approach, which can all too easily be adopted by beginning language students–and competency with a graphics package for digital making is akin to the acquisition of a new language–is the diminution of confidence in the learner who perceives the learning environment as providing an obstacle to be overcome in passing the course.

The formative IT Skills Surveys conducted with enrolling students over several years have revealed a steadily increasing reporting of base skills with computers in general. There is an increase in term time internet home access (from 47% in 1999/2000, to 73% in 2001), as well as an increasing reporting of use of email. However there is scant increase in reported previous use of graphics programs. The ubiquity of familiarity of using a PC, Windows, and the web (97%) dictates a *context* for entering the university digital classroom. The tasks directed for initiating digital learning then build on this context without the teacher having knowledge of student's *confidence* in that context.

We used in-classroom interviews to tease out the relationship between initial digital making and pre-existing confidence–to analyse what it was in the students' approach to learning which predisposed a confident approach and led eventually to gaining competence with the medium. The actual tasks required to be performed for the initial 'games' in CAD 1, D & F 1 and BE 1 comprised gathering and managing information (eg zipped files) and learning graphics package key-board and making skills in an environment where assessment stakes were low. In HC 2/3 the initial tasks comprised gathering and managing web-based information and presenting it on a website or as a power-point presentation. The illuminative responses reveal that:

- The reliability of the IT Skills Survey is compromised in that students may overstate their prior learning computer background in order to conceal perceived deficiencies;
- Students look for similarity with previously encountered computer situations to cue their learning in a completely different software application;
- The importance of showing a commitment to completing the computing requirements for coursework is vital for graphics package users who have no prior computer graphics skills;
- Belief in oneself, that with University entry level skills and knowledge, the fear of the (seeming) impossibility of mastery of a complex graphics package can be overcome;
- Time on task is necessary for students to overcome lack of practice familiarity with graphics packages. This point relates to students who, in the past, whether at School at University, have used graphics packages. Their rusty learning skills are critical in removing their former confidence.

For inexperienced and experienced users alike, the growth of confidence in using a complex graphics package results from making a commitment to their own learning outcomes. This is accompanied by the possession of personal learning attributes of perseverance, 'keeping things in perspective', and re-learning half forgotten skills, often initially acquired in a surface approach to learning which has not been retained. Enabling a computer classroom where these attributes are valued relies on allowing students to show their ignorance instead of their knowledge. The teacher's coaching role is all-important here in encouraging students through breaking complex skills down into simple tasks. Students' self-statements reveal that it is not the enormity of acquiring competency with digital graphics packages which is the confidence reducing part, but simple tasks such as unzipping files, submitting work, and managing information. They acknowledge that it is disadvantageous to be 'behind' the class, which underscores the importance of the teacher's coaching role.

**Well designed discussion assignments facilitate meaningful cooperation among students**

Biggs (Biggs, 1999 pp16-17, 37-40) informs our valuing of reflection for learning. His SOLO taxonomy for scaffolding higher order skills relates better learning outcomes to moving up the taxonomy from simple tasks of naming, memorisation, and learning procedures through to higher order skills of reflection, hypothesis, generation, application to far domains and relating to principles. Is this higher level knowledge informed by access to peers? Is online learning able to offer the trust predating effective group work? Interviews and focus groups conducted during 'illuminative evaluation' revealed that students:

- are unfamiliar with bulletin boards as a means of online communication;
- are wary of the substitution of online communication for face-to-face meeting;
- anticipated that they would interact meaningfully with student peers face-to face at University;
- use other students online as a source of information and resources;
- appreciate the opportunity to scaffold their learning from each other's knowledge using on-line discussion boards;
- use discussion boards only 10% as frequently if they are not part of the assessable tasks compared with when they form an assessable course component;
- draw heavily on peers in the computer suite to resolve immediate learning issues;
- do not become (quantitatively) better judges of their own and others' work through engaging in peer evaluations but report other beneficial higher order skills outcomes like increased reflection.

The development of trust and intra-group confidence as a means to effective group work, and peer collaboration, are challenges for course development. In a digital making, online learning environment, which *could* be an essentially passive and individual learning environment, communication and co-operative strategies must be embedded in the course design, and fore-fronted in assessable tasks.

**Students should present course projects**

There are some instances in which there is a need for online presentation of course projects. Such a tool for the presentation of projects must fulfil the same functionality as face-to-face presentation in terms of the dynamic cycle of presentation and response, and opportunities to respond, as a student, to peers' projects, in order to engage active learning. The utility of the vGallery (Woodbury et al., 2000) as a student submission, exhibition and critiquing system, with exhibitions configured to allow viewing of submitted projects by exhibitors, and public, and critiquing configured to allow critic, self, and peer assessment supports asynchronous presentation of course projects of any type. Illuminative evaluations reveal that:

- Students use the online presentation of other students' projects formatively to gain ideas before their project is completed. For instance, they review presentation, graphics, content, and things they have forgotten;
- Students are dismissive of the potential for gains from plagiarising from each other's projects, viewed formatively online for two reasons:
  - they crave the opportunity to be independently creative;
  - the risk of exposure in a web-based environment is very great.
- Students found feedback on the vGallery useful to their learning.

The efficacy of the vGallery as a tool to support presentation of students' course projects in an online environment has resulted in vGalleries being established for presentation purposes in many Faculties and Departments of Adelaide University.

**Instructors need to provide two types of feedback: information feedback and acknowledgement feedback**

Creating an online learning course that succeeds in maintaining the quality of face-to-face encounters is dependent on replicating the high quality learning environment created in the classroom. By providing timely and detailed feedback students are encouraged to adopt a deep learning approach. But Graham et al. (2001) propose that where online submission systems are utilised, students' hand-ins are receipted as a means to confirming that the online assessment requirements are successfully lodged, or have been received for assessment. Failure to do this causes students' unnecessary anxiety which then impacts on their ‘learning investment’ for the next project should they believe that their work has not been received, or is being delivered into the ether without someone at the other end reading and, in time, responding to it. Whilst discussion boards and the vGallery are self-acknowledging in that what students can see of their exhibit is what the assessor can see, students' need for acknowledgement appears to extend beyond simple *visibility* of their submission to the knowledge that the assessor has seen it. Therefore, seemingly trivial acknowledgement receipt (an email response, or evidence of having read a discussion board, or viewed a vGallery) is part of structuring a classroom where students will invest in their own learning. Evaluations reveal:

- Students anticipate receiving frequent communications from the teacher in an online environment as acknowledgement of their online submission to discussion boards;
- Extrinsic motivation continues to play a part in shaping intrinsic motivation;
- Teachers believe that communication with their students is improved though online communication possibilities. They need to make a realistic contract with their students about how often they will visit, or contribute to, online discussions (to provide both acknowledgement and information feedback) and their likely turn-around time for assessable online work.

**Online courses need deadlines**

The production of a high quality digital learning environment which focuses on what *exactly* it is that students' need to learn, rather than time consuming extraneous digital making, aligns students' propensity for adoption of a deep approach with a teacher's commitment to the provision of clear guidelines and standards for what is to be learned. It leads to a perception that the teaching is well organised (Biggs, 1999 pp16-17). The time investment for both the teacher to arrange learning activities that are shaped to exactly focus on students' learning needs, and the student to acquire skills, and showcase skills-as-assessable-knowledge in a digital environment to a pre-defined timeline, is substantial. The evaluations reveal that:

- Teacher's time investment in refining digital learning objects is substantial;
- Teachers believe that their digital learning objects are an exemplar for student's digital making, and must be free of flaws;
- Students learn effectively when they are immersed in a digital environment with well made and well structured digital objects;
- Students need to invest many hours to achieve worthy digital objects, and that they are poor predictors of how long digital making will take them. Consequently they underestimate the time required on digital tasks. Deadlines loom before they have completed their assigned coursework.
- Lack of graphics packages at home forces many students to study solely at University.

The students' encounters with learning objects designed to assist them to meet their deadlines are sometimes less than optimal because the detailed background development work (carried out by the teacher) is hidden in their first encounter with the sophisticated digital models whilst they are struggling with information management and familiarity issues.

**Challenging tasks, sample cases, and praise for quality work communicate high expectations**

Web-based submissions and exhibition possibilities developed through the vGallery (Woodbury et al., 2000) expand the potential for students to learn from sample cases, both from viewing their peers' submissions, and in-classroom presentations that emphasise excellence, and model self-judgement. The explicit (but confidential) application of criteria and standards is particularly important. In BE1 where the teacher's expectations for each assessment grade was clearly communicated through the vGallery there was a low 4% withdrawal rate, and the average overall grade was 69.6% over 83 students. Notably, students with the lowest University access (TER) scores in the class nonetheless succeeded academically. The lowest quintile outperformed all but the top 40% of students enrolling.

**Allowing students to choose project topics incorporates diverse views into online courses**

Students benefit from intrinsic interest in the tasks they perform, as they are more likely to devote time and energy to completion of the tasks at a higher order learning level - thereby adopting deep learning approaches in task completion. The ability to assemble a large amount of electronic resource data using online learning eases the management of offering multiple topics. Classroom management techniques to allow students to self-select topics is further eased when students can view topics online with online resource material (http://www.arch.adelaide.edu.au/games/e-research/resources.htm)

## CONCLUSION

Success in using on-line learning requires a careful matching of learning objectives to available tools and to students' pre-existing knowledge of those tools. While students can develop further computer skills in the process of completing required tasks (and such development may be a primary or secondary aim of the task), where there is too big a gap between required and pre-existing skills students feel overwhelmed. Often the difficulties experienced are over secondary issues–file handling, on-line submission of work etc – rather than the core task being undertaken.

Both our own experience, and reported experience elsewhere, confirms that the teacher's role is not diminished with on-line media, and that the teacher's presence in a new 'coaching' role in the asynchronous classroom, is as important as the teacher's traditional, in-classroom, role as information provider. The 'halo' effect of the teacher in on-line learning is noted in the teacher's asynchronous presence, in the teacher talk expounding the task, placing emphasis and directing learning individually, and through encouraging the desired deep approaches to learning through appropriate course design in which teaching is aligned with achieving deep approaches through providing choice in what is learned, and setting clear standards and criteria within a strong organisational structure.

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