LEARNING FOR UNDERGRADUATE BUILT ENVIRONMENT STUDENTS: PROJECT BASED ACTIVITIES, PROBLEM SOLVING AND ROLE-PLAYING FOR A COMPLETE EXPERIENTIAL EDUCATION

Geoff Outhred[1]

School of Property, Construction and Project Management RMIT University, GPO Box 2476V Melbourne, Victoria 3001 Australia

Most students enrolled in the Construction Management and Property programmes come to the university with little or no knowledge of the responsibilities and activities undertaken by architects, project managers, facilities managers, quantity surveyors and construction managers. They also vary greatly in their appreciation of sustainability issues for the built environment. This research presents a longitudinal study of a subject in the curriculum, designed for first year students in their second semester, which involves them in undertaking a series of activities, from design through to construction of the scale model of a house. These activities simulate the real world activities of the construction industry professionals mentioned above. The students also carry out a variety of role-playing and problem solving activities that develop their professional knowledge, awareness and expertise. Some other activities relate to the application of technology that the students have covered in previous and concurrent subjects. The research carried out shows that the undergraduate students in various construction industry disciplines responded very well to this style of teaching, and the beneficial outcomes of this experiential learning project are presented. The difficulties encountered are also presented, when projects of this type, with intense activities, are undertaken for large student groups.

Keywords: experiential learning, model building, problem solving, project, role playing.

BACKGROUND

This paper outlines some philosophies and strategies behind the development of a subject involving design, documentation and model making of a house for the common first year of the School of PCPM undergraduate course at RMIT University. The research involved is an ongoing longitudinal study that follows the subject's development from 2005 through to 2007. A summary of the teaching programme is given, which is followed by reactions to the subject by the students, and some evaluation findings of whether the subject achieved the intended objectives of "Quality in Teaching".

In 1994, the then Department of Building and Construction Economics, along with other departments in the Faculty was reassessing and developing many subjects in response to an RMIT University initiative to look at "Quality in Teaching". It was

[1] geoff.outhred@rmit.edu.au

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decided to develop some innovative teaching programmes, particularly for the first year students, to see if students' learning could be enhanced. One such programme was a week-long camp for all first year students, which was run in early first semester and was extremely successful. Another programme, to be developed and run by the Department, was a project for designing and building a house model making exercise for a large portion of Second Semester of first year. From 1998 until 2004 a programme called "Bike n' Build" was also provided as an elective subject for the third year students. "Bike n' Build" involved the students in cycling to a suburb of Melbourne, or in some cases to a regional town in Victoria, where they assisted in the construction of a house for HABITAT for HUMANITY. This is an international organization that enables housing to be provided to families who otherwise could not afford it. In 2004 the "Bike n' Build" took place in Western Samoa. Also in 2004, the Department of Building and Construction Economics merged with the Department of Property to form the new School of Property, Construction and Project Management within the Portfolio of the Constructed Environment at RMIT University. As a result of this merger, and also of the decision to run a common programme for first year students across all disciplines, the number of students grew from 65 to 180 in 2005, and to 230 in 2006. The School was subsequently faced with redeveloping the model making exercise into a subject that would not only cope with the increase in student numbers and diversity, but also continue to meet the "Quality in Teaching" objectives that RMIT continues to place before academic staff.

To respond to these challenges, a new subject entitled "Residential Design and Construction" was developed, to begin in Second Semester of 2005. It was further refined for 2006, and was given a new name "Residential Design and Measurement". The 2006 version is the major topic of this research, with reference to the 2005 version. The subject is described in more detail under "The Project" later in this paper, but essentially it was intended to draw upon the skills and knowledge the students had brought with them from subjects in First Semester, such as Design Appreciation, Architectural Drawing and Construction Technology, and utilize these by undertaking all of the stages of a project.

INTRODUCTION

As stated in the RMIT University "Teaching and Learning Strategy" paper (Dunkin and Bangay, 1994), RMIT seeks to produce students who are knowledgeable, creative, critical, responsible, employable and leaders. The attribute "knowledgeable" is central, and can be related to both the detailed content in a particular professional or occupational field and also to broader content intended as a basis of general educational outcomes.

The paper continues with the following:

> *"The curriculum should emphasize student (learner) – centred approaches, directly link industry/occupational/professional needs with specified course outcomes, provide a framework for the use of a wide variety of learning/instructional resources and strategies by adopting flexible delivery…."(Dunkin and Bangay, 1994)*

Boyle (1994), in his draft paper, "Quality in Teaching: Valuing, Recognizing, Evaluating and Regarding it", identifies the following characteristics of Quality Teaching:

- High quality and clearly articulated learning goals

- Flexibility in approaches to teaching and learning (including assessment)
- Good organization of subject matter and course, including relevance and coherence of content and planned teaching-learning activities
- Effective communication
- Knowledge of and enthusiasm for subject matter and teaching
- Facilitation of learning through student interaction and active experience
- Respect for and positive attitude toward students
- Critically reflective orientation to teaching including effective use of feedback to guide learning and improve teaching
- Appropriateness and fairness in assessment and grading

The "Residential Design and Construction" subject was developed with these characteristics in mind, and an attempt was made to respond to them one by one.

Mellander (1993) lists five "Learner's Pleas":

- Don't stifle my natural curiosity – awaken it!
- Just give me the information I need – not a lot I don't need!
- Let me think things through myself and draw my own conclusions
- Help me find contents of the things I have understood
- Help me use my knowledge so it doesn't wither away and become useless

These "Learner's Pleas" were to be a foundation for the detailed development of the subject. Activities were carefully designed and assembled to ensure that these theoretical student's pleas would be heard and responded to. The second plea "Just give me the information I need – not a lot I don't need", was a trigger to substantially alter the measurement and estimating approach for 2006, as a result of feedback from 2005. This is described later in this paper in "Developments and Enhancements"

Kolb defines learning as follows:

> *"Learning is the process whereby knowledge is created through transformation of experience" (Kolb, 1994)*

This definition of learning, in the context of Kolb's discussion, suggests that true learning can be associated with experiential learning.

Learning by action is closely identified with experiential learning, and Revans (1983) states that there can be no learning without action and no (sober and deliberate) action without learning. This view is reinforced by:

> *"Action learning is the antithesis of believing that we can do nothing about our situation. Whatever the context, people who use action learning believe that there is always something, however small, that can be done or positively not done." (McGill and Beatty, 1995)*

Other teachers in tertiary institutions are exploring the benefits of experiential learning. Linda Kestle of UNITEC in New Zealand notes some feedback from her students:

> *"The view of the designer, as opposed to the builder, helped us to explore different principles and it helped to trigger new ideas, which may not have been possible with the internal staff due to their different experiences." (Jefferies and Kestle, 2001)*

Brewer *et al.* (2001) discuss that a quality graduate should have the necessary attributes, including the ability to apply knowledge and skills in practical settings,

moving away from the accumulation of factual knowledge, and towards an understanding of the underlying principles that can applied to situations in the future. This opinion was influential in the modification of the subject from 2005 to 2006. These modifications are described later, in "Developments and Enhancements".

AIMS/OBJECTIVES OF THE PROJECT

Using the "Quality in Teaching" methods and philosophies mentioned above in the Background and Introduction as a starting point, the specific objectives of this model-making project were:

- To enable students to identify and appreciate the processes and constraints associated with designing a house
- To allow students to experience working together in a design, management and construction team for a particular project
- To enable students to gather together much of the information they obtained in First Semester subjects, place it in context, and appreciate how to use it
- To simulate the activities of professionals within the construction industry
- To expose students to the many frustration faults, snags and other problems that can be encountered in the construction process
- To further develop communication skills in both written and graphic formats
- To encourage and develop drawing techniques and three-dimensional presentation methods, and to enhance the student's understanding of the implications of drawings upon the construction process
- To give the students a simulated model of the construction procedures for a residential timber framed building
- To give a three-dimensional appreciation of building structure and form, and to relate this to two-dimensional information formats, ie drawings
- To place students in the position where they experience group dynamics in the extreme form, and observe their reaction and response

THE PROJECT

A brief summary of the project is given:

- Of 13 weeks duration, for 4-hour Friday studio sessions
- Commenced in Second Semester 2005 following on from related first semester subjects, including drawing and construction technology. Developed and refined for Second Semester 2006
- Students formed in groups of four (five in 2006 due to greater numbers) for initial activities and then two groups merged into a group of eight (ten in 2006) to construct the model
- Groups were self-forming and required to nominate respective group members to play the role of Architect, Project Manager, Builder and Construction Economist
- Each group was given a brief for the project (house), from a hypothetical client. The brief included an actual block of land for the house, so students were able to inspect the site if they chose to. The brief also included the Town Planning and Building Regulation (plus Environmental Sustainability in 2006) constraints applicable to the site
- Groups designed their house in response to the brief
- Groups planned construction sequence of their building

- Groups designed size and spacing of all framing members using light timber framing guides
- Groups measured and quantified their house, and built up a cost estimate (In 2006 they also undertook assessable measurement and estimating exercises for other case studies)
- Groups worked out quantities of required materials, and ordered them. Staff then supplied necessary balsa wood, mostly in pre-cut sizes, in response to their orders
- Models were displayed in a School of PCPM exhibition area after final assessment by a panel

Specific student tasks

The first task for the groups of four students was to produce a Schematic Design proposal for their house, in response to the brief from the hypothetical client, and to the actual block of land constraints. Students were further challenged in 2006 by the requirement that their design must meet the principles of Environmental Sustainability. The task included the preparation of Floor Plans, Perspective and a Design Report. After client approval, the group prepared Sketch Plan documents, comprising Site Plan, Floor Plans, Isometric and Design Analysis. When the client approved these, students prepared the basic Working Drawings for their house. Having done the design and documentation drawings, students used these documents to measure quantities of materials and to submit an estimate for their house. In 2006 they were given a more rigorous appraisal of Measurement techniques by an external Quantity Surveyor, and conducted assessable exercises for this topic prior to application of it to their own house design. Then they used their quantities calculations to make an order for balsa wood for the model. The balsa is available in certain sizes and lengths, and the students reduced their actual size framing components to the equivalent balsa size, at a scale of 1:20. Once their order was received, they were issued with the balsa, and used it to build the model. There was no further issue of materials, so they had to make do with what they ordered.

Prior to ordering the balsa, two groups merged into one group of ten people (in 2006), and agreed upon the preferred house design to be built, choosing from the two respective groups' designs. Having selected a design, the group prepared a complete framing schedule for all components of the house, including wall studs size and spacing, all lintels, beams, joists and rafters. This was a formalization of their initial quantities calculations to order the balsa. The next task for the group of ten was to prepare 1:20 scale framing drawings of all walls, roof framing and floor structure. These drawings formed the template for the model to be built. The final activity was for the group to construct the model over a four week period. They did this both in the supervised tutorial times, and at other times by group agreement. A presentation day was set up, at which each group presented their model to the assessment panel, and submitted a folio of all drawings and activities, including a diary. The assessment panel was given a proforma marking sheet to assist them, with proportional scoring of different assessment criteria.

Staff involved

The academic staff involved in this project comprised the lecturer/coordinator, and a team of six tutors. Three (four in 2005) of the tutors were final year students who had previously been through an earlier version of this subject in their first year of study. The other three (two in 2005) tutors were appointed as expert part time staff, and were

working elsewhere as an architect, quantity surveyor and project manager respectively. The quantity surveyor also presented three briefing lectures for measurement and estimating activities in 2006. After the activity briefing by the lecturer, outlining the problem and resultant task to be done, students would go to six allocated rooms, each with a tutor, where they would undertake the activity and submit it to the tutors for assessment. The three non-student tutors would assess the activity and return it with feedback for the next weekly session. The lecturer would circulate amongst the tutorials, acting out the role of the client.

The final model presentation was made to a selected assessment panel, made up of academic staff from the School of Property, Construction and Project Management, and invited industry representatives, some of whom were tutors in 2006. A motivating prize was awarded to the best group in 2006.

Assessment

No exam was set for this subject in 2006. The entire assessment was based upon the project and all of its activities. In 2005 an exam was conducted for the Measurement component, but for the following year this was replaced by assessable exercises. Assessment for the project, for both 2005 and 2006, was concerned with four specific aspects of the students' activities:

- For Drawings
- For Models
- For Involvement
- For correctness of technological and quantifiable information

More specifically, critical points for assessment were:

- Design aspects of the house, and consideration of sustainability issues, in particular passive solar design features, given far more prominence in 2006
- Correctness of framing members designed, and competency in measurement and estimating activities, both for their house and other case study projects in 2006
- Clarity and accuracy of drawings, along with quality of presentation, and the ability to convey the house design features and attributes
- Amount of input by each individual and demonstration of management skills, planning ability, leadership and/or team involvement. This was developed as a more rigorous assessment tool in 2006
- Presentation, accuracy, strength, stability and method of model construction, and ability to competently answer questions from the assessment panel

The Schematic Design drawings and Design Report were assessed, as were the Sketch Plan documents, and the Working Drawings. Work submitted as a result of the Measurement and Estimating activities was assessed. Project planning and programming documents were also assessed in 2006.

The large scale framing drawings were not assessed, as they were merely an assisting technique for constructing the model and the students could choose how best to utilize them.

The balsa materials order was not assessed in 2005, but it was in 2006. It was necessary to add this assessment to ensure the students made a serious attempt to provide an accurate result. In 2005 students suffered accordingly if they ran out of materials, or were left with an embarrassing surplus, but on many occasions the students would send a group representative to plead with the staff to provide them

with additional balsa wood. This did not occur in 2006 after the activity became assessable. The model itself formed a major component of assessment, as it was the culmination of all activities, and was physical evidence of the degree of success with which the students undertook the project. As the students worked their way through the activities involved in the project, a spreadsheet of all individual progress was maintained. Therefore if a student within a group was falling by the wayside, this would become evident from ongoing records. Whenever a group submitted some work, a condition of submission was that every individual student must sign off the work that they did, as a component of the submission. This ensured that non-performing students were not "carried" by the other group members. To reinforce this, each group submitted a diary where, amongst other discussion they described which group member did what. They were encouraged to discuss the non-contribution of any group member, and this information was used to review the individual student's progress and determine their assessment. Therefore whilst the diary was not actually an assessable component, it was used to assist assessment of other parts of the project.

Out of a class of 180 students in 2005, eight failed the subject, and this was really due to failing the exam more than a result of minimal overall participation. In 2006, only three out of 230 failed, for the latter reason. If the groups had one or more poorly performing member, the active members brought this to the attention of staff members in the interview at the model presentation or in the questionnaire. Students also had the opportunity to make comments in their group diaries. A further interview was conducted with the poorly performing person(s) in question to determine whether they should pass the subject. Therefore peer assessment was conducted in a subtle way, and amalgamated with the staff assessment. The methodology for this was enhanced in 2006.

FEEDBACK AND STUDENT RESPONSES: 2005 VERSUS 2006

For 2005 and 2006 each individual student was given a questionnaire to fill out at the conclusion of the project. They were also interviewed in their groups, partially to give answers to specific questions (which were assessable), and partly to give verbal feedback for the subject (non-assessable). Further feedback was provided by the diary that each group produced during the semester of activities. Some interesting comments are listed below:

- "We ran out of materials for our model. There wasn't enough"
- "Paul did not pull his weight in our group. He said he would bring in the wall frames after doing them at home and he did not even show up!"
- "We didn't know other people to form a group with"
- "I do all the work in the group"
- "Jeff has done the stumps and footings for our group, and he has glued them down in the wrong location"
- "There is not enough time to do the model"
- "I wanted to use our house design but the other group would not agree"
- "Measurement is a pain. I am a Property student and I don't see its relevance"

These comments demonstrate the very real frustration experienced by the students, not so much from a lack of teaching and guidance, but from a lack of cooperation from some of their fellow students (or in the simulated real-life project activities, the very real human failings exhibited when a culturally and professionally diverse team is

trying to successfully carry out a project). From the written questionnaires, positive feedback was forthcoming, 96% of the students felt that the project did successfully achieve their understanding of the processes involved in designing and building a house, and of residential construction framing. Not one student complained of a perceived lack of overall relevance.

The "Good Teaching Score" was 57.

Some comments from the 2006 students included:

- "Josh did not participate in the drawings. We had to do his for him"
- "I hate CAD"
- "The Measurement lecturer was great. He really helped me to get the idea"
- "CAD makes the framing drawings easy"
- "Eric left the wall frame at home"
- "I love this hands-on work"
- "We spent endless hours on our model, but we are pleased with it"
- "Our house is the best"

These comments are an interesting mix of passionate positive and negative responses. But overall they show that the students were very involved in the project, and in many cases got quite a "buzz" when partaking in the activities.

From the written questionnaire, 87% (96% in 2005) said that the project successfully achieved their understanding of processes. No student complained of a lack of relevance, and the "Good Teaching Score" was a significantly higher 68.

International students

The first year intake for Residential Design and Measurement included approximately 30 overseas students in 2005. In 2006 this increased to 40. These students continued to have problems and obstacles set before them that were not evident for locally sourced students. They still demonstrated poor communication, inability to understand subtle management concepts, difficulty in coming to terms with Australian methods of construction technology, and still had a tendency to cluster together within their own ranks. However as a group they tended to produce better work for the Measurement and Estimating exercises conducted in 2006, than for the exam in 2005 for the same topic. Many of them also, with encouragement, formed groups with local students, and some were extremely proactive in the activities when in these mixed groups. There may have been an element of competitive behavior involved.

OBSERVATIONS

For both years 2005 and 2006, the general standard of the models was extremely high. They were technically correct in their construction, built accurately to scale and they portrayed interesting and innovative yet still buildable houses. The models of 2006 were notably better for design refinement, and demonstrated some innovative sustainability solutions, such as rainwater storage and solar cell systems built into the fabric of the house. The students also used their 1:20 scale drawings to great effect in both years, using a copy of their drawings as a template for wall, floor and roof framing. It is an ongoing reassurance that, for both 2005 and 2006, when staff interact with these students who are in their second year, it is evident that the students are applying the skills, learning techniques and communication methods from the project, effectively to their present study.

The "Good Teaching" score from the questionnaires was 68 for 2006 compared to 57 for 2005. Contrary to this, the staff had some serious problems in 2006, mainly in keeping control of individual students during the activities, and apportioning assessment fairly. This is probably a result of the staff to student ratio increasing from 30 to almost 40 in 2006.

DEVELOPMENTS AND ENHANCEMENTS

In response to student feedback from 2005, and after reviewing the aspects of experiential learning theory, the following developments were made to the subject Residential Design and Measurement for 2006:

- Measurement and Estimating were assessed by exercises rather than an exam (response to assessment feedback and to: *"Just give me the information I need – not a lot I don't need"* (Mellander, 1993)
- A professional external quantity surveyor presented three Measurement and Estimating lectures (response to the enhancement of experiential learning)
- The balsa order became assessable (response to the need to make students more accountable for this, as they would be in a real professional situation)
- External professionals were added to the assessment panel, and more were used as tutors (taking experiential learning a step further, and giving students more respect for their assessors. Also a response to: "Facilitation of learning through student interaction and active experience" (Boyle, 1994)
- Environmental Sustainability criteria were applied to the house design (maintaining students' awareness of current issues)
- Planning activities were given more prominence (enhancing application of management skills and professional responsibilities)

The School of PCPM is about to run the project again in Second Semester 2007, for the current first year students and those involved are presently asking themselves and others how the project can be improved, in the interest of maintaining "Quality in Teaching". Thankfully the School enrolments for this subject will reduce in 2007 from 230 back to 180, as for 2005. This should address the problem of losing control of individual students. A method of making the project more in tune with present technology is to further encourage the use of CAD (Computer Aided Drawing) and enable the students to produce their detailed 1:20 scale drawings for framing using CAD. In 2006 they complained of how tedious these multiple drawings are to prepare with pen on paper. Increased use of CAD is justifiable for 2007 as the students have been given a more comprehensive introductory CAD course in Semester One this year. There is also the ability to "take off" quantities of materials and components through the CAD package. As for 2005, the 2006 students had a preference for producing their Sketch Plans and Working Drawings using the traditional drawing method for these documents. The School now has adequate resources for using CAD in laboratories that the students are able to book, so the students' choice to use CAD will be better catered for.

An ongoing question is whether it is preferable for students to select the group members themselves, or for staff to do it. If staff selected the groups this could partially overcome the problem of the overseas students' tendency to cling together, but on the other hand the group selection process is a valuable part of their

management learning curve. There is also a problem in that the student intake is far more multi-disciplinary now, and there is a need to actively encourage the property students to team up with the construction management and project management students in groups. It appears to be good practice to continue with students selecting their own groups, but with guidance from the staff where appropriate.

CONCLUSIONS

The project continues to comprehensively meet the aims and goals for experiential learning. It was again a rewarding experience for the teaching staff to work effectively at a professional level with the students. Most students demonstrated the beneficial outcomes of the project in their following year of study. The most significant aspect of their behavior is an awareness of the many frustrations and obstacles that confront professionals in the built environment sector. Yet they also show an appreciation of the rewards possible. Projects that involve role-playing of real professional situations have many learning and development benefits that conventional lecturing methods can never hope to achieve. That does not mean these projects should replace lectures, but that they should reinforce the subject material, and answer the "Learner's Pleas" listed by Mellander (1993). The subject Residential Design and Measurement is an "alive" subject, as it requires constant monitoring, nurturing and improvement to ensure it is relevant to future students. A number of changes are planned for its implementation in 2007. This project continues to qualify as a successful "experiential learning" project, and meets the RMIT University requirements for "Quality in Teaching".

REFERENCES

Boyle, P (1994) "*Quality in Teaching: Valuing Recognizing Evaluating Rewarding it*" Draft paper produced by EQUARD, RMIT University.

Brewer, G., Martins, R., Kolomy, R. and Chen, S. E. (2001) Assessment and Learning: Connecting Theory and Practice *In* Pullen, S, Mehrtens, V, and Zillante, G (Ed), *26th Annual AUBEA Conference*, 11-13 July. 2001, University of South Australia, Australian University Building Educators Association.

Dunkin, R and Bangay, R. (1995) "*Teaching and Learning Strategy*" Draft paper emanating from a senior RMIT University staff meeting at Queenscliff, Victoria in November 1994.

Jeffries, M. and Kestle, L. (2001) Enhancing Experimental Learning of Environmental Sustainability Using External Cross-fertilization *In* Pullen, S, Mehrtens, V, and Zillante, G (Ed), *26th Annual AUBEA Conference*, 11-13 July. 2001, University of South Australia, Australian University Building Educators Association.

Kolb, D. (1994) "*Experiential Learning: Experience as the Source of Learning and Development*" Prentice-Hall, Englewood Cliffs, NJ, USA.

McGill, I. and Beatty, L. (1995) "*Action Learning, a guide for professional, managementand educational development*" 2nd Ed., Kogan Page, London.

Mellander, K (1993) "*The Power of Learning*" American Society for Training and Development.

Omsman, H (1991) "*Taking Control of Training*" ABC Books. .

Revans, R. (1983) "*The ABC of action learning*" Chartwell Bratt, Bromley.