The Impact of Teaching Models, Group Structures and Assessment Modes on Cooperative Learning in the Student Design Studio

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Abstract

As a result of ever diminishing teaching resources, an increasing number of architectural educators are setting group design projects, rather than spreading their time thinly over a large number of individual projects. This allows them to co-ordinate longer and more in-depth review sessions on a smaller number of assignment submissions. However, while the group model may offer an authentic learning model by reflecting design in practice, the approach is not without its obvious shortcomings as a teaching archetype for the assessment of the knowledge and skill competencies of individual students. Hence, what is clear is the need for a readily adoptable andragogy for the teaching and assessment of group design projects.

The following paper describes the background, methodology and findings of a Strategic Teaching and Learning Grant funded research project carried out in the year 2005 at the School of Architecture and Building at Deakin University. The project aimed to inform a change of classroom/studio practice governing the assemblage, teaching and assessment of student design teams. The development through these changes of cooperative and student-centred learning principles focused on effective design collaboration and fair assessment should, it will be argued, lead to an enhanced group-learning experience in studio, which will subsequently and ultimately enhance professional practice.

Keywords: Continuous Assessment, Cooperative Learning, Design Andragogy, Experiential Learning, Peer Assessment, Student-centred Learning
Introduction

The two hundred years of apprentice/master tradition that underpins the atelier studio system is still at the core of much present day architectural design education. Yet this tradition poses uncertainties for large numbers of lecturers faced with changes in the funding of tertiary education. With reductions to one-to-one staff/student contact time, many educators are finding it increasingly difficult to maintain atelier-teaching models. Questionnaires from unit co-coordinators of design studios taught at universities across Australasia and the United Kingdom, received as part of a Deakin University Strategic Teaching and Learning Grant (STALG) funded project, indicate that funding cuts have seen decreases in one-to-one student-teacher contact time and increases in group project work becoming international trends. These changes are increasingly apparent at Deakin where until five years ago design teaching still followed a traditionally resource intensive Atelier model with studio time occupying for most year groups, one and a half days of the weekly timetable. In third-year in 2000, for instance, four tutors comprising two full-time staff and two sessional staff (sourced from professional practice) offered between eighty and a hundred students a total of thirty hours of tuition per week. This allowed all students around twenty minutes of one-to-one tuition per week. Moreover, in 2000 there were only two major group design projects in the five-year architecture program at Deakin. By 2005, third-year studio had been reduced to four hours per week, taught by one full-time unit co-coordinator partnered by one sessional tutor (although it should be noted here that at the time of publication (2006) a change to the curriculum encouraging team-teaching now sees each studio taught by two full-time unit co-coordinators partnered by two sessional tutors). With the number of group design projects consequently jumping to six in the first four years of studio, students have little access to one-to-one tuition before their fifth year. Studio tends now, to merely provide a forum for groups of around six to fifteen students at a time, to discuss with a tutor the development of design solutions evaluated and advanced in response to not just specific questions relating to one particular student’s work, but rather to issues that are common to the group. This model is in distinct contrast with the traditional paradigm of the over-the-shoulder teacher-centred transmission model of knowledge (i.e. direct transfer of knowledge from tutor to student) and follows more closely the paradigm of student-centred group learning.

Although group projects allow lecturers to co-ordinate longer and more in-depth review sessions, the approach is not without its obvious shortcomings as a teaching and learning archetype for the assessment of the knowledge and skill competencies of individual students. What is clear is the need for a readily adoptable andragogy for the teaching and assessment of group design projects. Research, therefore, at the School of Architecture and Building at Deakin aims to inform a change of classroom/studio practice by focusing on the three issues central to successful cooperative learning; these are:

1. Group Assemblage
2. Assessment
3. Teaching Models
This should lead to an enhanced group-learning experience, which should subsequently deepen individual learning of collaborative design skills and, ultimately, enhance collaborative professional practice.

**Background: Atelier Geelong - A Review of Assessment, Group Formation Methods and Teaching Models**

Atelier Geelong is a collaborative group design project that has been running for three years, during which time it has been the focus of efforts to improve teaching models, assessment and formation of groups. Through qualitative feedback from students in 2003 and 2004, new methods were developed and implemented in 2005 addressing the three issues of group assemblage, assessment and appropriate group teaching. The effectiveness of these methods was researched and assessed as part of the STALG funded project. A brief review of Atelier Geelong’s reflexive evolution over the last three years highlights why and how this program has attempted to redress the shortcomings of prior group design projects.

**Assessment**

The Atelier Geelong is designed to provide living accommodation and studio schemes for Geelong graduates and a supervising tutor. The project was organised in such a way that the design could readily be subdivided into three distinct elements. The 2003 brief concluded by asking design teams to break their submission and presentation into three separately appraisable elements for the final review. This is a requirement that highlights the first problem of team design projects, for what is commonly desired is one design solution that reads as consistent and ‘seamless’, but one that allows for the separate appraisal of those who devised it. Three years of trialling assessment models in the Atelier Geelong program has revealed that if team design is to reflect the type of collaboration demanded by professional practice, then the product of the design process can only be assessed as a team product, and that the assessment of an individual’s contribution to the project must focus rather on the process of design. As tutors are party to only a fraction of the design process, then only the students themselves can accurately evaluate contributions to this process. The appropriateness of this model was underlined by the preliminary questionnaire given to students at the beginning of Atelier Geelong 2005, in which seventy percent of students preferred from a number of assessment models offered, anonymous on-line peer assessment of the individual contribution to the design process, coupled with the unit co-ordinator’s assessment of the end project. This is not surprising in light of the fact that seventy percent of students felt that in previous group projects not everyone had contributed evenly. The program in 2005 has therefore implemented peer assessment methods - the process by which groups of individuals rate their peers (Falchikov, 1986; Oakley et al., 2004) - which are being developed and evaluated to allow students to assess one another’s performance in a group within the secure and anonymous environment of a web portal.

The peer assessment model has team-members log-in to web page at the end of each week to complete a chart in which each student rates themselves and their team-mates using two quantitative measures and one qualitative feedback measure. The first measure asks
students to award their peers a percentage of a team grade, but as students often award each other unrealistic multipliers of the team mark that are far higher than tutors would give, a problem known as peer over-marking ((Falchikov, 1986; Freeman and McKenzie, 2000; Roach, 1999), this first measure was backed up by a second that asked students to rate each other on a five point multiple-response Likert scale evaluation. This Likert evaluation, which is commonly used to rate aspects of the group experience (Ellis and Hafner, 2005), also allows for the coding of responses and the subsequent statistical analysis of possible patterns of bias in student assessments. It was hoped too, as Dominick et al. (1997) have found, that students who completed the qualitative feedback section, even if they themselves did not receive feedback, might be motivated to improve their performance. The purpose of the third qualitative measure, which asked students to comment on the performance of their peers, was to elucidate anomalies or unexpected final evaluations. At the end of the project an assessment matrix is generated for the teams that awards each student a multiplier of the team grade awarded to the final submission by the unit co-ordinator. Eighty-five percent of students in 2005 were awarded multipliers within the range of 0.9 – 1.1, for the only students heavily penalised were those who were consistently rated by all their team-mates as under-performing. Significantly too, and in line with the findings of Filene (1969) and Falchikov (1986), the computed average grades and accompanying qualitative comments assigned by students usually approximated the grades and comments assigned independently by tutors to back-up and test peer grades.

**Group formation**

Collaborative learning refers to an instructional approach in which students work together in small groups towards a common goal (Dillenbourg, 1999), which in the subject of this study is a design schema for Atelier Geelong. The Atelier group project was developed not only as a response to restricted resources, but also in an effort to emulate group working in practice, so that students could be taught the collaborative skills needed to negotiate infinite design options within a building design process that can include numerous participants and consultants (Cuff, 1991). The decision was further informed by research into group working within the education system, which has shown that students who partake in educational programs that integrate small group learning projects achieve higher grades, learn at a deeper level, and retain more information whilst gaining communication and team-working skills ((Brown and Dobbie, 1999; Oakley et al., 2004).

Tutors can allow students to self-select team-mates or can allocate them to specific groups. Allocated groups can then either be randomly assembled or engineered to create teams containing a range of experiences and abilities. Each method has its own merits, and although some students may prefer to be allocated to a group and may view this as fairer, particularly if the groups are randomly selected, experience at Deakin has shown that self-selecting groups are usually more popular for they minimize personal conflict and reduce the need for tutor intervention in disputes. It was for these reasons that students were allowed to choose their own team-mates for the 2003 Atelier project. The teams were seen to learn cooperatively via three primary forms of collaboration that have been termed Democratic,
Oligarchic, and Timarchic (Tucker, in print). Each of these will be briefly examined now in turn.

The team-working of approximately forty percent of the 2003 teams can be described with the term ‘democratic collaboration’. This resulted when there was no clear leader, and/or in most cases of this type when students were too polite, or of such similar ability, that they felt they had no right to criticise at any depth. In such cases, all ideas were treated as equal, meaning that those developed were those elected democratically. This often implied that the ideas selected had prompted the fewest objections, which frequently resulted in a product that in advertising parlance is commonly and unkindly known as “lowest common denominator”. This clearly was not a mode of collaborative working that encouraged risk, for as Schrage implies, innovation is more often than not the product of a diverse range of skills and abilities (Schrage, 1995). The problem of hierarchy within a group, or rather the lack of it here, is one that this paper will briefly return to for it is a significant one.

It can be seen from the analysis of past results that in 2003 groups of the democratic type were comprised largely of students of similar abilities. Indeed, the reason why this type of group accounted for the majority seems to be that students, when allowed to choose whom they worked with, chose like-minded peers with similar levels of skill. This is one of the primary reasons much of the research literature argues against allowing students to choose their own teams (Oakley et al., 2004) for when allowed to self select they will, in often choosing peers of similar ability, decrease their exposure to different ideas and perspectives that could have helped motivate new areas of learning. The democratic collaborators could be split into three sub-groups - the high, low and the average achievers as defined by their previous project marks. The average achievers, numbering seven, were the most widespread type of democratic group. There were two groups of high achievers, including one group comprised entirely of students who had in the previous semester achieved at least a 70 % grade or higher. The high quality of work produced by these two teams was in contrast to the work produced by the five low achieving teams comprised largely of students who had merely achieved pass grades the previous semester. Indeed, four of these low achieving groups failed the project and the contrast between their work and that of the higher achievers became the source of discontent. When the low achieving groups became acutely aware of how far they were behind the high achievers at an interim review, their already lesser motivation was seemingly reinforced, for some saw the skills imbalance as an insurmountable disadvantage. Their initial frustration at their own perceived lack of ability became externalized to a discontent with the course and program structure, therefore feeding into a notion described in the field of social psychology as the “Self-Fulfilling Prophecy in the Classroom” (Deibel, 2005; Smith and Mackie, 2000). To redress the disadvantage felt by weaker students it was decided in future to avoid putting them in what they themselves clearly identified as a situation that amplified their weaknesses rather than addressing them.

The groups driven by one or two high achievers in 2003, which numbered six - the least common of the three primary collaborative modes – can be referred to as ‘oligarchic collaborators’. Not only did these groups often produce the most accomplished and
innovative designs, but also they usually resulted in a positive learning environment for everyone. This included low achievers, who in these groups were often encouraged to develop previously unchallenged abilities. Here, hierarchy within the group was certainly of benefit.

If forty percent of the teams could be described as democratic and twenty percent as oligarchic then, in turn, to describe the organization of approximately another thirty percent of the teams we might use another term with Platonic origins (the same philosophical basis of the personality theories that will be relied upon later in the research), namely ‘timarchic collaboration’. For, in common with Plato’s description (Plato, 1955) of a society divided by internal strife and characterized by conflict and selfish ambition, this last type of group was born out of dissent. Often the result was piecemeal design with little cohesion.

The allocation of students to larger teams of six or seven in 2004, engineered to contain a range of different experiences and abilities as dictated by the previous semester’s grades, aimed to counter the perceived disparity in the quality of the different teams’ work that in 2003 had so undermined the self-confidence of low achieving students. This attempt was considered to be successful, for in 2004 not one team failed the group project Atelier Geelong. Yet this significant victory was achieved at great cost, for the distribution of the three modes of group collaboration saw in 2004 a large increase in the proportion of timarchic teams. Grouping strangers rather than friends led to much more conflict. This overshadowed the feeling of a small but significant number of students that the diversity and sometimes inherent hierarchy of a mixed ability group enhanced collaboration.

In response to student feedback and tutor observations from 2003 and 2004, the method for group formation in 2005 incorporated personality type theories to more effectively engineer teams, in an aim to reduce the number of timarchic collaborators and gain the best of both self-selection and group diversity. Personality testing has already proven popular amongst students within the faculty, as a way of identifying how different team-role preferences can benefit collaborative working. It also has a long history in educational literature as an effective way of engineering productive group environments (Chambers et al., 2000; Chang and Chang, 2000; Deibel, 2005; Durling et al., 1996; Gorla and Lam, 2004; Rutherfoord, 2001). Both the Procedure and Results section of this paper will outline the results of the personality testing and its related effects within the course.

**Teaching Methods**

Over the past three years it has become apparent that as well as group formation and assessment, the tutorial structures for Atelier Geelong also needed adapting to the evolving andragogy. To make collaborative learning successful it is important to shift the student’s role from a passive receiver of information into an active participant (Dominick et al., 1997; Umbach and Wawrzynski, 2005). This is most successfully achieved through the process of problem based learning (PBL) (Banerjee and De Graaff, 1996; De Graaff and Cowdroy, 1997). PBL is both a curriculum and a process. The curriculum consists of carefully selected and designed problems that demand from the learner acquisition of critical knowledge, problem solving proficiency, self-directed learning strategies, and team participation skills.
The process replicates the commonly used systemic approach to resolving problems or meeting challenges that are encountered in life and career. PBL is typically advanced in small discussion groups of students accompanied by a tutor. A constructed, but quasi-realistic problem is presented in consecutive sections, mimicking the gradual acquisition of potentially incomplete information in real life situations (Lai and Tang, 2000). The students discuss the case, define problems, derive learning goals and organise further work (such as literature and database research) (Dochy et al., 2003). This can also be referred to as ‘student-centred learning’ as first theorised by Carl Rogers (1983) in which, instead of emphasising the transfer of knowledge by teachers, focuses on stimulating the student’s own learning processes (Savery and Duffy, 2001). Thus, in the 2005 Atelier Geelong project, students worked in small groups on a single design project advanced through review sessions that have teams who alternate roles between designers and clients. When the students take on the role of the client they are expected to constructively criticise and explore the other team’s design. In this instance the tutor’s role is more of a facilitator than purveyor of knowledge, providing the scaffolding for students to follow and build upon as they interact with their peers (Vygotsky, 1978).

**Methodology**

It must first be noted that at the beginning of this study the methodology foci was on exploration and qualitative feedback from students. Students of the third-year first semester design unit (3A) were given a questionnaire at the beginning of the unit and again at the end. Student responses have been subsequently coded as dependent variables allowing for a summary statistical analysis to compare student attitudes towards group formation, assessment and teaching models before and after the Atelier Geelong project. These responses will also be analysed in terms of the independent variable of personality pools to explore the effect of personality on group work. A marks comparison will be made between pools and also between the third-year design unit - 3A, the group project that forms part of that unit - Atelier Geelong, and the neighbouring design units 2B and 4A (which also include group work but have not been the focus of any experimental adjustments). Observational data of client/design team review session has also been compiled along with data from focus group discussions and tutor reflections.

**Participants**

Ninety-four architecture students were asked to take part in an experiment running in conjunction with 3A and the Atelier Geelong project. Seventy-six agreed to participate of which thirty-five were female, forty-one male.

**Materials**

Materials included the Keirsey Temperament Scale (Keirsey, 1998), and observational data recording sheets.
Procedure

The ninety-four third year architecture students who were asked to take part in studio observations and some questionnaires were informed that the study would be focusing on group formation, assessment and teaching models. Those students that elected to participate were then asked to complete a seventy-item Keirsey Temperament Scale Questionnaire (Keirsey, 1998). It was explained to the students that the reason for the questionnaire was to show how different personality traits can influence the roles adopted and preferred by members within groups. The results from the Keirsey Temperament scale formed the basis for the three pools: A (same personality style: Concrete Co-operators), B (mixed personality styles) and C (control group of students including those who elected not to participate) from which the students would be allowed to self-select. Self-selection from within an engineered pool was deemed a necessary component, for it had been demonstrated in previous years and in the field of psychological research into group productivity levels, that a certain level of efficacy is needed when setting up group work within a class (Hendry et al., 2005). Indeed, the psychology social learning theorist Albert Bandura (1962; 1975) has conducted much research into the effect of heightened senses of self efficacy to show that such awareness improves the disposition and productivity levels of people not only at work but also in their personal life.

Results of personality testing

The results of the type testing has shown that while students were, as illustrated in Figure 1, of a wide range of personality types, a number of “function” types dominated their motivation. Of the students that sat the test, 57% can be described as extroverts, while 43% can be described as introverts. The most common of Jung’s eight types in the cohort is the Extroverted Sensation type, which number 39% of those tested, whilst the least common was the Introverted Thinking type, which numbered only 9%. 67% of the cohort was driven by Sensation rather than Intuition, and 70% by Feeling rather than Thinking. Moreover, and perhaps most notably, 90% could be characterized as Judging rather than Perceiving. Thus, 55% of the cohort conform to the one-of-four Myers personality category termed as the Concrete Co-operators – a type Myers had characterised as observing their close surroundings with a keen eye for the purpose of “scheduling their own and others’ activities so that needs are met and conduct is kept within bounds” (Keirsey, 1998, p. 19). Students of this type were grouped together in one pool to form seven teams. Pool B was a mix of different personality types, from which students could again self select, while pool C was the control group, including students not wishing to take part in the experiment.

After the teams had been devised, participants were asked to complete a questionnaire regarding their attitude to previous group work activities in other units. The design unit 3A then followed the prescribed curriculum incorporating a number of observational sessions and focus groups. At the end of the unit, participants were asked to complete a second questionnaire on group work and related components as experienced in 3A and the Atelier Geelong project. Results of these surveys coupled with mark comparisons across subjects and projects for the last three years will be described in the next section.
Results

Although only summary data was available for exploratory analysis, results indicate that 3A and the Atelier Geelong project in 2005, both of which have been the focus of the STALG project and its corresponding experimental conditions, have been the only classes to show any significant improvement in marks across the last three years compared to the previous design unit 2B and a subsequent design unit 4A (see Table 1). All three classes were analysed using a one-way analysis of variance (ANOVA). Levene’s test for homogeneity of variance was considered. However, as all groups were of similar size, when this assumption was violated the ANOVA statistic was still considered to be robust.

Results from the questionnaires given to students prior to starting the 3A Atelier Geelong project indicate that there was an overall negative response to group work then. A Chi-Square analysis concluded that all four questions targeting attitudes towards group work yielded a significant difference in favour of a negative response (see Table 2).

At the end of 3A students were again asked to complete a questionnaire regarding their experience of group work and continuous assessment throughout 3A and Atelier Geelong. A factorial analysis (the method of factor analysis was Maximum Likelihood with an Oblique Rotation - justified by the high correlation between items on the test - averaging 0.75) was performed on the questions formatted to a Likert scale rating style which indicated that although many different sections of the course were being targeted in the questionnaire (such as assessment, group work, personality etc) they all were reliably accounted for (Lambda 0.96) by a single factor. This was supported by the parallel and the MAPS test, which both concluded one factor to be an appropriate extraction number. The factor pattern matrix showed that all items loaded heavily onto one factor with the lowest communality at
0.45 and the majority at 0.80 or above. A single sample t-test indicated that overall there was a significant improvement in student attitudes towards group work (M 2.64, SD .832) t (65) = -3.477, p < .001. However, a one-way ANOVA indicated that when comparing the three pools of participants A, B and C, there was no significant difference between groups in their attitudes towards group work after 3A and the Atelier Geelong process f(2, 63) = .499 > .05. As illustrated in Figure 4, there did however seem to be trends emerging within the data indicating the preferences of all three pools for group work after the Atelier project.

Table 1 One Way ANOVA

<table>
<thead>
<tr>
<th>Class</th>
<th>Years</th>
<th>Sums of Squares</th>
<th>DF</th>
<th>F statistic</th>
<th>Significant &gt; .05</th>
</tr>
</thead>
<tbody>
<tr>
<td>2B</td>
<td>2003 - 2005</td>
<td>Between Groups 87.481</td>
<td>2</td>
<td>.272</td>
<td>.762</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Within Groups 39458.890</td>
<td>245</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total 39546.371</td>
<td>247</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3A</td>
<td>2003 - 2005</td>
<td>Between Groups 1407.735</td>
<td>2</td>
<td>11.105</td>
<td>** .000**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Within Groups 16732.424</td>
<td>264</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total 18140.159</td>
<td>266</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atelier</td>
<td>2003 - 2005</td>
<td>Between Groups 2324.341</td>
<td>2</td>
<td>12.314</td>
<td>** .000**</td>
</tr>
<tr>
<td>Geelong</td>
<td></td>
<td>Within Groups 25198.355</td>
<td>267</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total 27522.696</td>
<td>269</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4B</td>
<td>2003 - 2005</td>
<td>Between Groups 112.633</td>
<td>2</td>
<td>.755</td>
<td>.471</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Within Groups 14990.720</td>
<td>201</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total 15103.353</td>
<td>203</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** Significant at the .000 level

A detailed analysis of the second questionnaire enquiries into students’ perceptions of the group project Atelier indicated that although no single component was significant (after the correct adjustments were made to the alpha level to protect against Type 1 errors) the three items that were significant at the .05 unadjusted alpha levels for one-way ANOVA were:

1. Question 12: A lack of leadership and / or hierarchy within our group in 3A made decision making difficult. f(2, 63) = 6.156 p < .05

2. Question 21: The weekly-assessed tasks throughout 3A helped the development of our designs for the Atelier Geelong project. f(2, 63) = 3.670 p< .05

3. Question 24: Continuous assessment throughout 3A has given me a greater understanding of what has been expected of me in the unit. f(2, 63) = 3.721 p<.05

It might be noted that although the three pools of students did not differ in their mean mark – all achieving 62.8% (a mean that approximates to 69% when non-completers are discounted)
- this was for the third-year first semester design unit the highest mean mark for the five years across which grades have been compared.

Figure 2 Means of Class 3A 2003 – 2005

Figure 3 Means of Atelier Geelong 2003 – 2005
Table 2: Preliminary Questionnaire to Students regarding attitudes towards previous group work experiences

<table>
<thead>
<tr>
<th>Observed Count</th>
<th>Expected Count</th>
<th>Residual Chi-Square</th>
<th>DF</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Observed</td>
</tr>
<tr>
<td>Has group work in other units been a positive experience for you?</td>
<td>24</td>
<td>47</td>
<td>35.5</td>
<td>11.5</td>
</tr>
<tr>
<td>Do you prefer to design in groups?</td>
<td>24</td>
<td>47</td>
<td>35.5</td>
<td>11.5</td>
</tr>
<tr>
<td>Do you feel that in group projects in previous units every contributed equally?</td>
<td>11</td>
<td>60</td>
<td>35.5</td>
<td>24.5</td>
</tr>
<tr>
<td>Do you think that the group design projects you were previously involved in were good preparation for professional practice?</td>
<td>14</td>
<td>57</td>
<td>35.5</td>
<td>21.5</td>
</tr>
</tbody>
</table>

** Significant at the .000 level

Figure 4 Means of Combined Factor Second Questionnaire to students’ Feedback on Group work

CBA

POOL

2.76
2.73
2.70
2.67
2.64
2.61
2.58
2.55
2.52

Mean of FTOT

A  B  C  P O O L
Conclusions

Although only summary data was available for analysis at the time of writing, preliminary findings have elucidated significant trends within the data. Firstly, it was shown that 3A and Atelier Geelong were the only two classes to show any significant improvement in mark allocation over the last three years. However, the pattern of improvement between the overall unit and the project Atelier Geelong differ markedly. It can be seen in Figures 2 and 3 that the overall unit 3A had an acute rise in mark average in 2005 whilst the scale of improvement for Atelier Geelong is slightly less acute rising in 2004 and then again in 2005. It could be hypothesized that this argues for the positive effect of the engineering of teams on grade average in the Atelier Geelong project, as in both 2004 and 2005, the engineering of teams was the only independent factor. Restrictions discouraging the option of working with friends, which encouraged diversity within teams, seemingly led to a more challenging learning environment. In 2005 this was achieved without the increase in timarchic collaboration that resulted from engineered teams in 2004, for allowing students to choose team-mates from pools avoided personality and social conflict. In contrast to the findings of Chambers et al. (2000), it is worth noting that the number of timarchic team collaboration structures appeared to be drastically reduced amongst the teams consisting of same personality types. It can be postulated that this reduction in the amount of interpersonal conflict that occurred may be due to the disposition of the personality type of the Concrete Co-operators towards regulating goals and conduct within the group in the absence of tutor intervention, which may have advanced the team’s cohesion.

A comparison of grades across cohorts suggests that the improvement in grade average in 2005 is linked intrinsically to the changes made in the structure of 3A. As a comparison of enter scores for the architecture course shows that 2005’s 3A student cohort was academically not significantly better than those of 2003 and 2004, it could be postulated that the acute grade average increase was at least partially linked to the skills enhanced and acquired in the improved program of Atelier Geelong. Moreover, both 3A and Atelier Geelong have shown significant grade average improvements when compared to the neighbouring courses of 2B, 3B and 4A, indicating that the adjustments made to assessment, teaching models and group formation have had a positive effect on the quality of student work.

This hypothesis is further supported by the second questionnaire returned by 2005 students who in their answers showed a significantly more positive attitude towards group work following participation in 3A and the Atelier Geelong project, than at the beginning of the unit. Although the questionnaire had no significant individual items (after the correct adjustments were made to the alpha level to protect against Type 1 errors), a factor analysis concluded that all items could be reliably accounted for by one common factor. When combined, the power of the statistical finding (i.e. the probability that it will yield statistically significant results) was increased to affirm a shift in student attitudes towards group work. Despite targeting aspects as varied as group work, personality, leadership and assessment, all of the items on the questionnaire could be accounted for by one single factor. This supports what has been long known in educational settings – namely, that a successful course design cannot be compartmentalised; it has to be an integrated whole, adaptive to the needs of
students and teachers as well as responsive to external constraints and the evolving requirements of the discipline itself. A detailed analysis performed on the items within the second questionnaire showed that those items that were significant at the unadjusted alpha level centred on attitudes to leadership and hierarchy within the teams and on a preference for continuous assessment. This came as no surprise in light of student feedback from 2003 and 2004, which indicated that the two major sources of discontent were unfair assessment procedures and a lack of organisation and hierarchy within the groups themselves.

Although there was no significant difference between pools in attitudes towards group work, trends can be seen to be emerging in the data indicating that groups of the same personality type had a more positive experience. This finding contradicts much of the popular literature supporting the use of personality testing to enhance not similarity but diversity of personality within groups. This may in part be due to the rational behind choosing the personality type ‘Concrete Co-operator’ (SJ = sensing and judging) for the similar personality pool A. This was not just because they accounted for 55% of the student cohort, but also because concrete co-operating personalities - who are defined as good task and time managers with skills in prioritizing, administrating, social justice and strategy - might prove the most productive collaborators. To form a pool based on this personality opposed to what is considered to be the archetypal temperament of a designer, namely introverted, intuitive, thinking and perceiving (INTP) (Kvan and Yunyan, 2005), may have contributed to the similar personality types fostering a more positive environment for collaborative learning.

The data has indicated informative trends suggesting that the adjustments being made to the Atelier Geelong project are helping to construct a more sustainable and successful andragogy for teaching studio design in the discipline of architecture. The adjustments have included the adoption of continuous, anonymous, and online peer assessment; of group formation as a blend of engineering and self-selection informed by personality theory focused on producing the best group working dynamic; and of a student-centred problem based learning and teaching model that is responsive to the needs of both the students and teachers whilst considering increasing resource restrictions and the evolving needs of the profession. There are numerous confounding factors and experimental design issues that future research will need to address if the study is to provide definite conclusions. These include standardising research materials such as questionnaires to follow the same rating style, constructing a control group of which the personality types are known, and gathering data to match similar personalities in groups composed of students with different levels of design skills. The negation of bias too is important, which might be aided firstly by creating a double blind experiment where observers are not aware of what groups they are observing so that observations can not be coloured with their expectations and, secondly, by having someone who is not a part of the experiment mark the assignments. It might also be appropriate to compare the marks of individual students for the previous two years, rather than the marks merely of the cohort as a whole; comparing those marks with their marks for 3A and Atelier Geelong to see if the adjustments made to the unit affect individual grade averages too, and present therefore a more universally successful andragogy as well as experimentally accounting for individual student’s skill levels. Of course, a similar controlling
mechanism could also be applied to a number of yet unidentified factors relating to the specific changes to the unit structure of the year under study. Despite these experimental limitations, the platform this paper provides for future research directions, informing a new andragogy for architecture design studios, is considered to be of paramount importance in the pursuit of maintaining design as a sustainable course structure. This is a necessary response in light of increasing resource restrictions being faced internationally by a majority of higher education institutions.

To sum up, we might draw from the trends that can be seen in the collected data the following broad conclusions. Firstly, that students perform better in group design projects than in individual design projects - a finding confirmed by questionnaires received from unit coordinators in design schools world-wide that have shown that the average grade achieved by students is 5% higher for group design projects; secondly, that the quality of work as measured in grades has increased in 3A at Deakin with continuous assessment that is anonymously peer assessed; thirdly, that students prefer continuous peer assessment of an individual’s contribution; fourthly, that students prefer continuous assessment to design projects assessed largely on final submissions; and finally, that students certainly see the learning value of continuously assessed tasks as a means of developing design solutions. These findings have successfully advanced the aim of researching and developing an improved teaching methodology for group work in the design studio. This conclusion is supported not only by the theoretical and practical experience of the researchers and tutors but is moreover directly informed by the students’ experience of the design studio – students who are the direct consumers of the different teaching, assessment and group models explored and developed here. What has become clear too from our study is something that educators in other fields have known for some time, namely that group-learning requires a very different model of teaching, and that this model has some advantages over teacher-centred one-to-one tutorials. The introduction of a more participatory student-centred design forum where learning takes place collaboratively with peers, rather than in an individualistic or competitive manner, appears to empower students to develop in tandem with their creative skills the diverse interpersonal, professional, and cognitive skills that are needed to filter and synthesise more efficiently the relevant information necessary for designing. Such a participatory model may even, it is hoped, foster sensitivity in students to listen as professionals to their future collaborative colleagues and, moreover, to their real clients and users.

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