# A Discipline-Specific Factor Analysis Approach to Using Student Surveys for Improvement

KATE PATRICK, ANTHONY BEDFORD, STEPHANIE ROMAGNANO, MICHELLE BEDFORD AND JAMES BARBER

*RMIT University, Melbourne, Australia*

Submitted to the *Journal of Institutional Research* 24 October, 2008, accepted 15 December, 2008.

## Abstract

Like other universities, RMIT recognises the significance of graduates' ratings of their experience and has had a long-term commitment to improving student learning. As at other universities, RMIT's standard subject-level survey (the Course Experience Survey [CES]) incorporates items from the national Course Experience Questionnaire, with the aim of eliciting student views and prompting improvements that will take effect before the students graduate. The university has been seeking strategies to make the results of these surveys more accessible to academic staff, so that staff can use them as a starting point for change.

The current project is part of this work. The starting point is discipline-based analysis of the university's CES data. Surveys were stratified into fifty disciplines, and categorical factor analysis applied to ascertain common interpretable factors. The results have been presented to staff for discussion in the context of planning for improvement.

This article explores the results of the factor analysis and its potential for providing academics with useful information on students' experiences.

*Keywords:* Student Feedback, Course Improvement, Higher Education, Quality, Teaching and Learning

> Effective teaching is more likely to be achieved by helping teachers to understand how to interpret research findings within their own context and circumstances, and so to identify the strongest influences on their own students. They will then be better able to think seriously about how their own practice can be enhanced in the light of the best research evidence currently available. (Entwistle, 2005, p. 81)

## Theoretical Background: The Significance of Disciplinary Differences

In 1993, the Course Experience Questionnaire (CEQ) was introduced in Australia as a graduate survey, designed to collect data on the quality of students' learning experiences in Australian universities. Since that time, while CEQ results have been used to measure university performance, annual data have consistently shown that they vary not by university

This paper was first presented at the Annual Conference of the Australasian Association for Institutional Research, *Enhancing Quality Research: a Global Perspective* held in Canberra, 19–21 November 2008.
*Correspondence to:* Associate Professor Kate Patrick, Quality Unit, RMIT University, GPO Box 2476V, Melbourne, Victoria 3001, Australia. E-mail: kate.patrick@rmit.edu.au.

but by discipline. There has been an overall improvement in the proportion of positive responses to CEQ items, but differences between disciplines have persisted.

The CEQ Good Teaching items focus primarily on the effectiveness of communication between academic staff and students. They were developed from work by Entwistle and Ramsden which demonstrated that effective communication with and by lecturers was strongly associated with students adopting a deep approach to their study and hence learning effectively (Ramsden, 1991, pp. 132, 135; Wilson et al., 1997, p. 43). These items were envisaged as a proxy measure of the quality of student learning.

The pilot data collected prior to the implementation of the CEQ as a graduate survey indicated strong and significant differences in the responses of students from different disciplines (Ramsden, 1991, p. 138). The persistence of differences between disciplines can readily be seen by inspecting the annual CEQ data, now available on the Graduate Careers Australia website (GCA, 2008) (see also Patrick, 2003, and the graph at attachment 1). In general, social science and humanities disciplines are highly rated on the Good Teaching scale, whereas science and engineering disciplines are relatively poorly rated. Ramsden recognised this in his initial paper on the CEQ; he concluded that the differences between disciplines in terms of culture and resources are so marked that comparisons between institutions should only be made within disciplines (Ramsden, 1991, p. 139).

Differences between disciplines in terms of approach to teaching have emerged from other studies. Using different items, Santhanam and Hicks (2002) analysed the differences in students' opinions in evaluating their lecturers and their subjects, across two principal discipline areas. The items in their study asked students to rate the effectiveness of the teacher and the effectiveness of the curriculum. In this study, sciences/mathematics students were more positive about the teaching they received than were arts/humanities/social sciences students. Santhanam and Hicks concluded that content differences between disciplines influenced both the teachers' approaches and the expectations of the students. This interpretation is consistent with Becher's view of disciplinary culture; he argues that there are significant differences between disciplines in teaching techniques, student learning needs, and curriculum design (Becher, 1994). Similarly, Lueddeke argues that disciplinary differences have a significant influence on academics' interest in scholarly reflection and teaching improvement (Lueddeke, 2003). Exploring teaching approaches, Trigwell, Prosser and their colleagues have also found disciplinary differences: they argue that expository teaching is more common in the 'hard' sciences and a student-centred approach more common in social sciences and the arts (see e.g. Lindblom-Ylänne et al., 2006).

Entwistle (2005) reports recent discipline-based investigations in the United Kingdom that complicate these assertions. He describes university education as a process of initiation into the complex culture of a particular field. While this does involve significant conceptual development (for which a 'deep approach' is particularly useful), he now sees it more broadly as the development of a distinctive, discipline-specific way of 'thinking and practising' (Entwistle, 2005, p. 72).

While recognising the significance of disciplinary cultures, Knight and Trowler (2000) also challenge the widespread practice of focusing on the individual teacher. They argue that attempts to improve students' learning experiences must take account of contextual and structural issues, and the changes that they have observed in university life over the past twenty years. In particular, they nominate intensification of work; managerialism and a loss of

academic autonomy; a loss of collegiality; 'greedy' institutions; and ageing, malaise and marginality among academic staff (Knight & Trowler, 2000, pp. 71–72).

The present project is designed to explore the dimensions of student experience at discipline level. The aim is to provide academic staff with data that connect with the experiences of their own students and which will be useful to them in identifying where and how students' experiences might be improved. This article focuses in particular on strategies for presenting the analyses generated by the project.

## Methodology

### *Sample and survey*

It is university policy that each subject [locally termed a course] conducts a survey at least once a year. The data analysed in the study derive from the 2007 subject surveys; the data analysed for this article were collected from surveys conducted in semester two (July — October). In this period, surveys were completed in 1466 Higher Education subjects across the university, covering 50 discipline areas — a total of 33,156 completed survey forms. Many students will have completed more than one survey form: full-time enrolment comprises four subjects per semester, and full-time students could well be asked to complete four surveys in a semester.

The survey instrument being used (the Course Experience Survey) has been locally developed to explore different aspects of student experience. While its statistical properties have not been previously evaluated, it does include the items of the CEQ Good Teaching scale (GTS) and other items from the CEQ. It also includes items relating to study resources and learning facilities.

Table 1 lists the items in the survey, along with the labels used by the researchers. The Good Teaching items from the CEQ are highlighted. Responses (as with the CEQ) are on a 5-point Likert scale, with 1 labelled *strongly disagree* and 5 labelled *strongly agree*.

**Table 1**
*Course Experience Survey items*

| | Course Experience Survey item | Label |
|---|---|---|
| 1 | The learning objectives in this course are clear to me | Objectives |
| 2 | I am learning what I expected to in this course | Expectations |
| 3 | This course is well organised | Organised |
| 4 | The teaching staff are extremely good at explaining things | Explaining |
| 5 | The teaching staff normally give me helpful feedback on how I am going in this course | Helpful feedback |
| 6 | This course contributes to my confidence in tackling unfamiliar problems | Problem-solving |
| 7 | Assessment tasks in this course require me to demonstrate what I am learning | Assessment |
| 8 | The amount of work required in this course is about right | Workload |
| 9 | The teaching staff in this course motivate me to do my best work | Motivate |
| 10 | I enjoy doing the work for this course | Enjoyment |
| 11 | I find the learning resources for this course useful (e.g., notes, handouts, readings, AV materials) | Learning resources |
| 12 | The web-based (online) materials for this course are effective in assisting my learning | Online materials |
| 13 | There is effective use of other computer-based teaching materials in this course | Computer-materials |

| | Course Experience Survey item | Label |
|---|---|---|
| 14 | The facilities (such as classrooms, lecture theatres, studios, labs) are adequate for this course | Facilities |
| 15 | I feel I can actively participate in my classes | Participate |
| 16 | There is good balance between theory and practice | Theory/prac balance |
| 17 | The teaching staff work hard to make this course interesting | Interest |
| 18 | I can see how I'll be able to use what I am learning in this course in my career | Use |
| 19 | The staff make a real effort to understand difficulties I might be having with my work | Understand difficulties |
| 20 | The staff put a lot of time into commenting on my work | Comment |
| 21 | Overall, I am satisfied with the quality of this course | Satisfaction |

***Data analysis***

In previous studies, the robustness of the CEQ scales has been tested by factor analysis across the whole body of respondents. Implicitly, this approach assumes that the dimensions of students' experience will be the same across different disciplines, and that what varies is the quality of their experience. By contrast, the present study uses factor analysis at discipline level, to distinguish the dimensions of student experience for each discipline (see Bedford et al., 2008).

Because responses to the survey items were on a Likert scale, which cannot be assumed to be linear (Linting, Meulman, Groenen, & Van der Kooij, 2007; Meulman, Van der Kooij, & Heiser, 2004), the data were first transformed using categorical principal component analysis (CATPCA). CATPCA is a non-trivial function of SPSS™ which commences analysis via optimal quantification, a process whereby categories of the categorical variables are appointed continuous numeric values (Linting et al., 2007; Meulman et al., 2004). This process provides the numeric values that are required for variance and Pearson correlation calculations (Linting et al., 2007). Importantly, the solution is iteratively computed from the ordinal data, as opposed to being derived from a correlation matrix, as with traditional principal component analysis (PCA) (Gifi, 1990). Like traditional PCA, CATPCA attempts to extract factors that can account for as much variance in the variables as possible. Because of the transformation of the fixed values into quantified values, CATPCA typically accounts for more variance than PCA (Linting et al., 2007).

Factor analyses were undertaken separately for each of the discipline areas for which data were available. The extraction method used was principal component analysis, with varimax rotation and Kaiser normalisation. Five factors were elicited, corresponding to the number of factors identified in traditional principal component analysis of CEQ data (see Ramsden, 1991; Richardson, 1994).

## Results

The five factor model had considerable explanatory power, accounting for around 70% of the variation in responses. An initial factor analysis across the whole cohort of students resulted in the emergence of a clear Good Teaching factor comprising five of the six expected items. At this level, the factors which emerged were:

- Good teaching: comment (Q20), give useful feedback (5), understand difficulties (19), motivate (9), interest (17)

- Engagement: use (18), enjoy (10), theory/prac balance (16), workload (8), problem-solving (6), participate (15), assessment (7)
- Organisation: objectives clear (1), organised (3), expectations (2), explaining (4)
- Resources: online (12), computer (13), learning resources (11)
- Facilities: facilities (14)

Analysis of variance using the established Good Teaching scale showed, as expected, strong and significant differences between disciplines, with mean scores ranging from 16 to 69 on a scale from -100 to +100. As in previous studies, engineering and business students rated their experience low on this scale by comparison with social science and education students. The results are shown for some example disciplines in Figure 1, below.

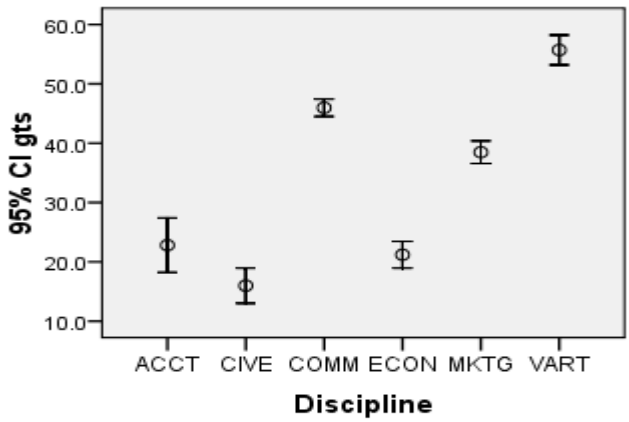


*Figure 1*
Student Good Teaching error bars, selected disciplines, Semester 2, 2007
*Note*: The disciplines shown are accounting (ACCT), civil engineering (CIVE), communications (COMM), economics (ECON), marketing (MKTG), and visual art (VART)..

The factor analyses by discipline complicate and add depth to this picture.

While the items from the CEQ Good Teaching scale were commonly associated in a single factor, the significance of this factor varied between disciplines, and items associated with the factor also varied. In 26 of the 50 disciplines, a Good Teaching factor emerged first from the analysis; however it was the second factor in 16 disciplines and less salient in the remaining 8.

Table 2 provides an example comparison of the two most salient factors in two disciplines, one from the social sciences, and the other from commerce. Mean scores on the standard GTS scale were relatively high for both these disciplines, as shown in Figure 1.

**Table 2**
*Example factor structures*

| | **Communications** ***N* = 2573** | **Marketing** ***N* = 1451** |
|---|---|---|
| Factor 1 | *Good teaching*<br>Questions 20, 5, 19, 9, 17:<br>20 Staff put a lot of time into commenting on my work<br>5 Teaching staff normally give me helpful feedback on how I'm going<br>19 Staff make a real effort to understand any difficulties I might be having with my work<br>9 Teaching staff motivate me to do my best work<br>17 The teaching staff work hard to make this course interesting<br>Factor accounts for 19% of variance | *Organised and purposeful*<br>Questions 3, 4, 2, 1, 17:<br>3 This course is well organised<br>4 The teaching staff are extremely good at explaining things<br>2 I am learning what I expected to in this course<br>1 The learning objectives in this course are clear to me<br>17 The teaching staff work hard to make this course interesting<br>Factor accounts for 19% of variance |
| Factor 2 | *Meaningful engagement*<br>Questions 10, 16, 15, 18:<br>10 I enjoy doing the work for this course<br>16 There is a good balance between theory and practice<br>15 I feel I can actively participate in my classes<br>18 I can see how I can use what I am learning in this course in my career<br>Factor accounts for 18% of variance | *Good teaching*<br>Questions 20, 5, 19, 9:<br>20 Staff put a lot of time into commenting on my work<br>5 Teaching staff normally give me helpful feedback on how I'm going<br>19 Staff make a real effort to understand any difficulties I might be having with my work<br>9 Teaching staff motivate me to do my best work<br>Factor accounts for 16% of variance |

Despite their relatively high and consistent GTS means, a similarly constituted good teaching factor emerged prominently from the analysis in both disciplines (though it was slightly more salient in communications, where it was the first factor, than in marketing, where it was the second factor). There were, however, substantial differences between these disciplines in the structure of the other leading factor. Looking at the items comprising this factor suggests that in marketing, there was variation in students' experience of their subjects as purposeful and well-organised; whereas in communications, there was variation in their personal sense of meaningful engagement.

This sensitivity to differences in students' experience is a key feature of the discipline level factor analyses. The particular combination of items constituting a given factor suggests a distinctive perspective on the meaning of the items. For example, responses to items about the organisation of the subject (questions 1, 2, 3 and 4) were frequently correlated. In some disciplines (for instance Accounting and Radiation Science) these items also correlated with responses to question 18 (on the usefulness of the subject), suggesting that the dimension related to whether the subject was seen as purposeful. In other disciplines (for example Nursing and Economics), they correlated with items on the requirements and outcomes of the subject (questions 7, 8 and 6), suggesting that the dimension related to the subject being seen as fit for purpose.

In addition to the diversity of the dimensions identified by the factor analysis, there was diversity in the salience of particular items within a factor. For example, there were several disciplines where question 19 (understanding difficulties) was the defining item on the

good teaching dimension. This is consistent with early CEQ results. However, question 20 (staff time on comment) was most frequently the defining item for this dimension. Historically, the graduate CEQ has shown a relatively low level of agreement with question 20, and the university has been emphasising the importance of providing feedback to students; it seems likely that the diversity of student experience of feedback has increased as a result.

***Reporting Results***

Once the factors had been identified, the items contributing to each factor were grouped together and reports prepared for each discipline showing the items most closely associated with the 'good teaching' factor. A sample image from the report is shown at Figure 2.


*Figure 2*

Items associated with the Good Teaching dimension.

*Note*: The numbers on the target are CES question numbers: the question closest to the bullseye is the one loading most heavily on the Good Teaching factor.

Additionally, each report includes a graph showing the level of agreement with each item and a table with the factor structure for the discipline.

The factor structure is also being used as the starting point for further work comparing student responses across subjects within the discipline: the project team has prepared graphs using error bars to show how students respond to associated items in different subjects.

However, communicating the results has been problematic. For staff unfamiliar with factor analysis, it is not obvious how to interpret an item that has the highest weighting on a factor, or how to interpret differences between factors.

The complexity of the factor analysis approach makes it particularly important to present the results using different perspectives. How might the key results of this work be presented so that the underlying logic is clear to a non-mathematician?

Three concepts seem to be fundamental.

**1. The highest loading factor is the one which captures the greatest variability.**

This implies that students give a wide range of responses to the items in the factor. If their responses were alike there would be no variability to capture.

Factors are calculated to have a mean of zero and a standard deviation of 1, so factor scores per se cannot be used to demonstrate the variability of the underlying data. However, one would expect subject-level factor scores to vary and therefore to provide data illustrating the diversity within the discipline. Figure 3 depicts means and 95% error bars for subjects in the economics discipline (N = 1207) (identifying detail removed).

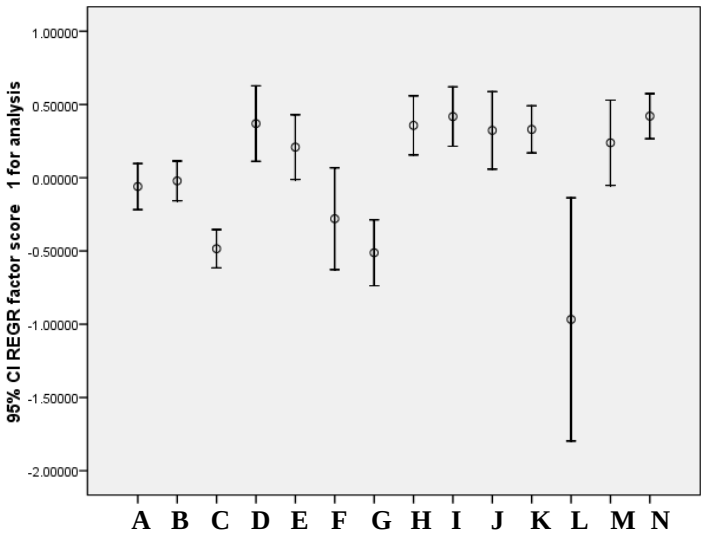


*Figure 3*
Error bars for Good Teaching factor scores, economics subjects.

As Figure 1 showed, Economics had a relatively low Good Teaching scale mean, of just over 20. Figure 3 shows that (as expected) the subjects within Economics are not all alike. As indicated by the 95% error bars, student responses are consistent within subjects — with the obvious exception of subject L, which had responses from only six students.

The circles in the error bars show the mean factor score for each subject. There are clearly significant differences between subjects, with some being rated much more positively than others. A couple of subjects (D and N) have a mean factor score nearly half a standard deviation above the mean, whereas two other subjects (C and H) have a mean score nearly half a standard deviation below the mean. D and N may offer examples of good practice; in C and H there appears to be considerable room for improvement. Hence analysis of factor (and item) scores by subject provides a useful starting point for further discussion.

**2. The highest loading item on a factor reflects the variation in the other items.**

This implies that there is variation in the responses to the highest loading item. It may be thought that the highest loading item on a factor will be one where there is strongest disagreement — the item which most needs fixing. This is not so.

This can be seen by looking at the distribution of responses to question 20 (teachers' time commenting on student work). As already mentioned, this was the defining item for the Good Teaching factor in many disciplines, including all the example disciplines shown in Figure 1. Although students were, as expected, much more positive in arts and social science disciplines, in all the disciplines there was a broad range of responses.

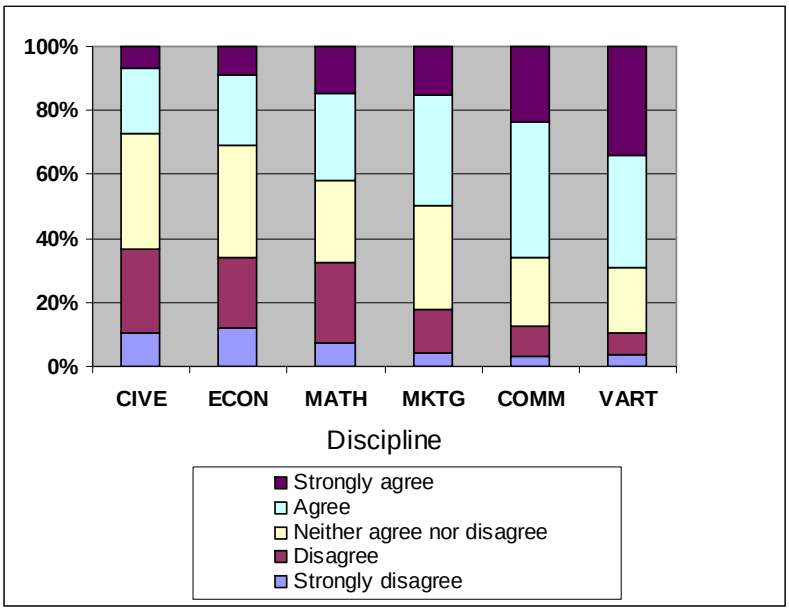


*Figure 4*
Distribution of responses to Q20: Example disciplines.

The defining item points to potential for examining both where students' experiences are positive and where they might be improved. In the knowledge that this item varies significantly within the discipline, it is clearly valuable to develop more fine-grained analysis looking at the experiences of different cohorts (international students, students articulating from TAFE, commencing and returning students). This work is being undertaken as part of the project.

### 3. Students respond consistently to the different items in the factor

An individual's response on one item in the factor is likely to be similar to their response on the other items. A student who disagrees with one item will be likely to disagree with the other items; a student who agrees with one item will be likely to agree with the other items. Hence, strongly disagreeing with an item in the factor will be associated with a low factor score and strongly agreeing will be associated with a high factor score.

Data from the project illustrate this. The graph below again draws on data from the economics factor analysis. It shows the distribution of Good Teaching factor scores according to the response the students gave to question 20 (time on comments).

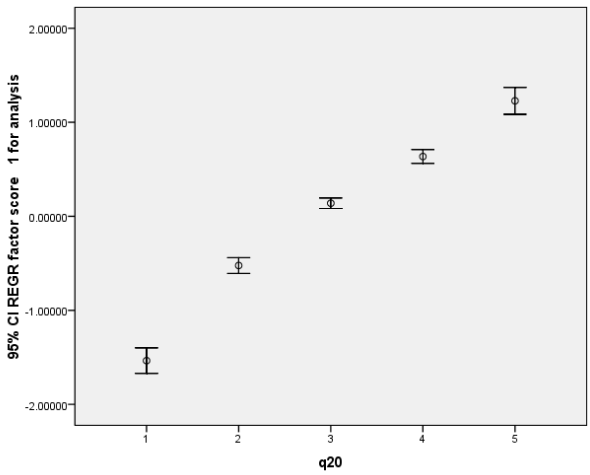


*Figure 5*
Error bars for Good Teaching factor scores, economics discipline, by response to Q20.

It can be seen that, within the discipline, students' experiences on this item are consistent with their experience of the other items included in the factor. The factor points to associated practices which can be considered as a set.

## Discussion

Using the discipline-level factor analysis provides more information about student experience than is visible from scanning item level agreements and scale means.

Applying this approach to Marketing, for example, it will be recalled that Factor 1 comprised items that seem to relate to students' experiences of order and purpose in the subjects being evaluated (see Table 2: extract below).

**Extract from Table 2**

| Marketing<br>*N* = 1451 | |
|---|---|
| *Factor 1: Organised and purposeful* | |
| Questions 3 4 2 1 17: | |
| 3 | This course is well organised |
| 4 | The teaching staff are extremely good at explaining things |
| 2 | I am learning what I expected to in this course |
| 1 | The learning objectives in this course are clear to me |
| 17 | The teaching staff work hard to make this course interesting |
| Factor accounts for 19% of variance | |

Following through on the theoretical discussion, we can say first that this is the dimension of student experience where responses from marketing students show most variation. Hence we know that on this dimension marketing subjects include both good practice and opportunities for improvement. Some students must have indicated that they were clear about what they are doing, that it matched their expectations, and that they understood the work; other students (or the same students in a different subject) must have indicated that they felt muddled about both the purpose and the content of the subject.

An obvious next step is for staff to explore these findings. Where are the difficulties students experience? Are there particular groups of students who find the marketing subjects confusing? Or are there particular subjects (perhaps problem-based subjects) where students are generally confused? Conversely: are there groups of students who are very clear about what they are doing and why? Or are there particular subjects that are generally agreed to be organised and purposeful? Answering these questions (via further data analysis or via direct discussion with students) will identify both opportunities for improvement, and exemplars of good practice within the discipline.

Secondly, the factor analysis tells us that, from the students' perspective, the items within this factor were related. Perceptions of order and purpose constituted a consistent dimension of the students' experience. This gives more to work with than the results for each item individually. We can conclude that once staff know where improvement is needed, it will be useful for them to make a concerted effort to improve and align communication with students about the intentions, outcomes and content of the subjects that are causing difficulty.

***In conclusion***

This project has considerable potential for enhancing the usefulness of subject survey data. The results can be used to:

- identify distinct dimensions of students' experience
- explore differences in students' experience within a discipline
- identify subjects within the discipline which are exemplars of effective practice on a particular dimension.

The disciplinary starting point focuses attention on the student's experience, rather than the teacher's performance. The factor analysis enables the identification of areas where students' experiences vary, so that within the body of practice in the discipline there is clearly both a need for improvement and positive exemplars. With discussion grounded at discipline and subject level, it should be possible to explore contextual and resource issues impacting on student experience, along the lines suggested by Knight and Trowler (2000). Used in this way, these analyses have the potential to provide a real jumping off point for change.

## References

Becher, T. (1994). The significance of disciplinary differences. *Studies in Higher Education, 19*(2), 151–161.

Bedford A., Romagnano S., Patrick K., Bedford M., & Barber J. (2008, November). *A discipline-specific factor analysis approach to evaluating student surveys at an Australian university*. Paper presented at the 8th annual conference of the South East Asian Institutional Research, Surabaya, Indonesia.

Entwistle, N. (2005). Learning outcomes and ways of thinking across contrasting disciplines and settings in higher education. *Curriculum Journal, 16*(1), 67–82.

Gifi, A. (1990). *Nonlinear multivariate analysis.* New York: John Wiley & Sons.

Graduate Career Council of Australia. (2001). *Code of Practice for the public disclosure of data from the Graduate Careers Council of Australia's Graduate Destination Survey, Course Experience Questionnaire and Postgraduate Research Experience Questionnaire*. Retrieved September 19, 2008 from http://www.universitiesaustralia.edu.au/content.asp?page=/policies_programs/graduates/ceq2003.htm

Graduate Careers Australia. (2008). *Course Experience Questionnaire data, 1994–2007*. Retrieved September 19, 2008, from http://www.universitiesaustralia.edu.au/content.asp?page=/policies_programs/graduates/index.htm

Knight, P.T., & Trowler P.R. (2000). Department-level cultures and the improvement of learning and teaching. *Studies in Higher Education*, *25*(1), 69–83.

Lindblom-Ylänne, S., Trigwell, K., Nevgi, A., & Ashwin, P. (2006). How approaches to teaching are affected by discipline and teaching context. *Studies in Higher Education, 31*(3), 285–298.

Linting, M., Meulman, J.J., Groenen, P.J.F., & Van Der Kooij., A.J. (2007). Nonlinear principal components analysis: Introduction and application. *Psychological Methods, 12(3),* 336–358.

Lueddeke, G.R. (2003).Professionalising teaching practice in higher education: A study of disciplinary variation and 'teaching-scholarship'. *Studies in Higher Education*, *28*(2), 213–228.

Meulman, J.J., Van Der Kooij, A.J., & Heiser, W.J. (2004). Principal components analysis with nonlinear optimal scaling transformations for ordinal and nominal data. In D. Kaplan (Ed.), *The Sage handbook of quantitative methodology for the social sciences* (pp. 49–70). London: Sage Publications.

Patrick, K. (2003, March). The CEQ in practice: Using the CEQ for improvement. In *Graduates, Outcomes, Quality and the Future*. GCCA symposium conducted in Canberra. Retrieved September 20, 2008, from http://gradlink.edu.au/content/download/833/3012/file/15.%20The%20CEQ%20in%20Practice,%20Using%20the %20CEQ%20for%20Improvement%20-%20Kate%20Patrick.pdf

Ramsden P. (1991). A performance indicator of teaching quality in higher education: The Course Experience Questionnaire. *Studies in Higher Education, 16*(2), 129–150.

Richardson, J.T. (1994). A British evaluation of the course experience questionnaire. *Studies in Higher Education*, *19(1)*, 59–68.

Santhanam E., & Hicks, O. (2002). Disciplinary, gender and course year influences on student perceptions of teaching: explorations and implications. *Teaching in Higher Education, 7*(1), 17–31.

Wilson, K.L., Lizzio, A., & Ramsden, P. (1997). The development, validation and application of the Course Experience Questionnaire. *Studies in Higher Education, 22*(1), 33–53.

Attachment 1

Illustrative means for CEQ Good Teaching, 2004–2007