

Using students' assessment of classroom environment to develop a typology of secondary school classrooms

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Research employing the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) was conducted in Australian secondary schools. A sample of 4,146 students from 286 classes responded to the TROFLEI which assesses 10 classroom environment dimensions: student cohesiveness, teacher support, involvement, task orientation, investigation, cooperation, equity, differentiation, computer usage and young adult ethos. Validation data attested to the sound structural characteristics of the TROFLEI. Cluster analysis was used to develop a classroom typology of five relatively homogeneous groups of classes which were described as exemplary; safe and conservative; non-technological teacher-centred; contested technological and contested non-technological.

Classroom environment, classroom typology, cluster analysis, technology-rich learning, outcomes-focused learning

CLASSROOM ENVIRONMENT RESEARCH

During the past 35 years, the study of classroom environments has received increased attention by researchers, teachers, school administrators and administrators of school systems. The concept of environment, as applied to educational settings, refers to the atmosphere, ambience, tone, or climate that pervades the particular setting. Research on classroom environments has focussed historically on its psychosocial dimensions, those aspects of the environment concerned with human behaviour in origin or outcome (Boy and Pine, 1988). Reviews of classroom environment research by Fraser (1998b), Dorman (2002), Goh and Khine (2002) and Khine and Fisher (2003) have delineated at least 10 areas of classroom environment research including: associations between classroom environment and outcomes, evaluation of educational innovations, differences between students' and teachers' perceptions of classrooms, comparisons of actual and preferred environments, effect on classroom environment of antecedent variables (for example, gender, year level, school type, subject), transition from primary to secondary school, school psychology, teacher education, educational productivity research, and using environment instruments to facilitate changes in classroom life.

Because of the ethical dilemma of deliberately manipulating environments in a true experimental design, almost all environment-outcomes research has used ex post facto designs and correlational data techniques. Results of studies conducted over the past 30 years have provided

convincing evidence that the quality of the classroom environment in schools has a significant influence on student learning (Fraser, 1994, 1998a). That is, students learn better when they perceive the classroom environment more positively. Importantly, many of these studies have controlled for background variables with students' perceptions of the classroom environment accounting for appreciable amounts of variance in learning outcomes, often beyond that attributable to background student characteristics.

During the last decade, significant research on the use of computers in classrooms has been conducted. Much of this research has focussed on the effect of computer usage on student attitude, social outcomes, motivation and interest (see Bain, McNaught, Mills, and Lueckenhausen, 1998; Goh and Tobin, 1999; Lajoie, 1993; Schofield, Eurich-Fulcer, and Britt, 1994). However, few studies have investigated psychosocial dimensions of computer classroom environments. In one study that did involve classroom environment, Mucherah (2003) investigated the environment in social science classrooms using technology. This study raised important issues concerning the inadequacy of training and support of teachers who attempted to integrate the use of computers in the curriculum. Recently, Dellar, Cavanagh and Romanoski (2006) reported associations between information and communication technology learning and classroom learning culture and Lu, Wan and Ma (2006) investigated the use of wireless laptops in college classrooms that purportedly had a constructivist learning environment.

The use of cluster analysis to establish typologies of classrooms based on assessments of classroom environment is not common. Moos (1978) developed a five-cluster solution with the following classroom orientations: control, innovation, affiliation, task completion and competition. McRobbie and Fraser (1993) used the Science Laboratory Environment Inventory in typological research in Queensland science classrooms. Brekelmans, Levy and Rodriguez (1993) employed the Questionnaire on Teacher Interaction in The Netherlands to develop a typology of teacher communication style that had eight profiles: directive, authoritative, tolerant and authoritative, tolerant, uncertain and tolerant, uncertain and aggressive, repressive, and drudging. In recent research, Rickards, den Brok and Fisher (2005) built upon this Dutch research to develop similar profiles for teacher communication styles in Australian schools.

The purpose of the present article is to report the use of a relatively new classroom environment instrument, the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) which has ten scales: student cohesiveness, teacher support, involvement, task orientation, investigation, cooperation, equity, differentiation, computer usage and young adult ethos. Details of the development and validation of actual and preferred forms of the TROFLEI using multitrait-multimethod (MTMM) modelling within a confirmatory factor analysis framework have been reported by Aldridge, Dorman, and Fraser (2004). The research reported in this article uses cluster analysis to develop a typology of classrooms based on TROFLEI data collected from a large sample of Australian secondary school students. The following section describes the study.

DESIGN OF PRESENT STUDY

Research Objectives

The present research had two objectives:

- a) to validate the TROFLEI using a large sample of Australian secondary school students, and
- b) to establish a typology of classrooms based on students' perceptions of classroom environment.

Sample

A sample of 4,146 students from 10 secondary schools in Western Australia and Tasmania responded to the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI). Table 1 describes the sample. These students were from 286 classes. One of the Western Australian schools in the sample has embraced technology to a very high degree with computer usage integrated throughout the teaching and learning activities and general administration of the school.

Table 1. Description of sample

| Gender | Sample Size | | | | | Total |
|--------|-------------|--------|---------|---------|---------|-------|
| | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | |
| Male | 78 | 57 | 71 | 1,138 | 591 | 1,935 |
| Female | 73 | 66 | 108 | 1,149 | 815 | 2,211 |
| Total | 151 | 123 | 179 | 2,287 | 1,406 | 4,146 |

Assessment of Classroom Environment

The TROFLEI consists of 80 items assigned to 10 underlying scales (8 items per scale). Table 2 shows scale descriptions and a sample item for each scale. Seven of the 10 TROFLEI scales are from the *What is Happening in this Class?* (WIHIC) instrument which is a well-established and widely-used questionnaire in classroom environment research (see Aldridge and Fraser, 2000; Dorman, 2003). The WIHIC scales are: student cohesiveness, teacher support, involvement, task orientation, investigation, cooperation, and equity.

Table 2. Descriptive information for 10 TROFLEI scales

| Environment Scale | Scale Description | Sample Item |
|----------------------|---|---|
| Student Cohesiveness | The extent to which students know, help and are supportive of one another. | I am friendly to members of this class. |
| Teacher Support | The extent to which the teacher helps, befriends, trusts and is interested in students. | The teacher considers my feelings. |
| Involvement | The extent to which students have attentive interest, participate in discussions, do additional work and enjoy the class. | I explain my ideas to other students. |
| Task Orientation | The extent to which it is important to complete activities planned and to stay on the subject matter. | I know how much work I have to do. |
| Investigation | The extent to which skills and processes of inquiry and their use in problem solving and investigation are emphasised. | I carry out investigations to test my ideas. |
| Cooperation | The extent to which students cooperate rather than compete with one another on learning tasks. | I share my books and resources with other students when doing assignments. |
| Equity | The extent to which students are treated equally by the teacher. | I get the same opportunity to answer questions as other students. |
| Differentiation | The extent to which teachers cater for students differently on the basis of ability, rates of learning and interests. | I do work that is different from other students' work. |
| Computer Usage | The extent to which students use their computers as a tool to communicate with others and to access information. | I use the computer to take part in on-line discussions with other students. |
| Young Adult Ethos | The extent to which teachers give students responsibility and treat them as young adults. | I am encouraged to take control of my own learning. |

The robust nature of the WIHIC's reliability and validity has been widely reported in studies that have used the instrument in different subject areas, at different age levels and in nine different countries. Since the initial development of the WIHIC, the questionnaire has been used successfully in studies to assess the learning environment in Singapore (Fraser and Chionh, 2000), Australia and Taiwan (Aldridge and Fraser, 2000), Brunei (Khine and Fisher, 2001), Canada (Zandvliet and Fraser, in press), Australia (Dorman, 2001), Indonesia (Adolphe, Fraser and Aldridge, 2003), Korea (Kim, Fisher and Fraser, 2000), the United States (Allen and Fraser, 2002), and Canada, England and Australia (Dorman, 2003). Within these countries, the WIHIC has assessed the environment in a range of curriculum areas including high school science (Aldridge and Fraser, 2000), mathematics (Margianti, Fraser and Aldridge, 2001), mathematics and science (Raaflaub and Fraser, 2002) and mathematics and geography (Fraser and Chionh, 2000).

Three new scales of educational importance were developed for the purpose of this study. In order to capture the individualised nature of an outcomes-based program, a differentiation scale was adapted from the Individualised Classroom Environment Questionnaire (ICEQ; Fraser, 1990). This scale assessed the extent to which the teacher provides opportunities for students to choose the topics on which they would like to work and progress at their own pace. Because technology-rich learning environments required students to use computers in a range of ways, the computer usage scale was developed to provide information about the extent to which students used computers in various ways (for example, email, accessing the internet, discussion forums). Finally, a young adult ethos scale was developed to assess the extent to which teachers gave their students responsibility for their own learning.

Historically, negatively-worded items have been used in classroom environment instruments to guard against passive responses. However, Barnette (2000) questions the utility of such items, as they could not be considered direct opposites of their positively-worded counterparts. In addition, studies have revealed that positively-worded items improved response accuracy and internal consistency (Chamberlain and Cummings, 1984; Schreisheim, Eisenbach and Hill, 1991; Schriesheim and Hill, 1981). It was considered appropriate, therefore, to use only items with a positive scoring direction in our study.

Students responded to items using a five-point Likert format, of 'Almost Never', 'Seldom', 'Sometimes', 'Often', 'Almost Always'. To provide contextual cues and to minimise confusion to students, it was considered appropriate to group together those items that belonged to the same scale instead of arranging them randomly or cyclically (Aldridge, Fraser, Taylor and Chen, 2000). Scale scores for each respondent were obtained by aggregating scores for the eight items for that scale.

Data Analysis

Scale scores were computed for each student. These scores were used to calculate scale means for each of the 286 classes. Hierarchical cluster analysis, a procedure which attempted to identify relatively homogeneous groups of cases based on selected characteristics, was performed on the data. Analyses used these scale means for each class to establish clusters of classes. To verify that the selected cluster solution separated the cluster groups, a multivariate analysis of variance (MANOVA) was performed on the data using the 10 TROFLEI scales as dependent variables and cluster membership as the grouping variable. Tukey's post hoc procedure was used to ascertain if pairwise comparisons of cluster group means revealed statistically significant differences.

RESULTS

Validation of TROFLEI

Factor Analysis

Detailed validation of the TROFLEI using confirmatory factor analysis has been reported elsewhere and is not reported here (see Aldridge, Dorman and Fraser, 2004). A principal components factor analysis with varimax rotation was performed on the data. It yielded 10 factors that accounted for 64.6 per cent of variance in TROFLEI scores. All items had loadings of at least 0.46 with the factor corresponding to their a priori scale and below 0.35 with other factors ($M = 0.70$, $SD = 0.08$).

Scale Statistics

Internal consistency reliability coefficients (Cronbach coefficient alpha) were computed for each scale with the individual student and class as units of analysis. Analyses conducted with the class as the unit of analysis used the class mean as the measuring statistic (see Table 3). These results show that all scales had good internal consistency. Indices ranged from 0.82 for differentiation to 0.95 for equity with the individual as the unit of analysis and from 0.86 to 0.98 with the class as the unit of analysis. They compare favourably with those reported in previous learning environment research (for example, Dorman, Adams, and Ferguson, 2002; Dorman and Ferguson, 2004).

Table 3. Scale statistics for 10 TROFLEI scales

| Environment Scale | Cronbach α | | Mean Correlation | | ANOVA $F(285, 3860)$ | Scale Statistics | |
|----------------------|-------------------|-------|------------------|-------|-------------------------|------------------|------|
| | Student | Class | Student | Class | | M | SD |
| Student Cohesiveness | 0.89 | 0.94 | 0.38 | 0.45 | 2.83 | 31.84 | 2.43 |
| Teacher Support | 0.93 | 0.97 | 0.41 | 0.48 | 5.51 | 28.97 | 3.69 |
| Involvement | 0.91 | 0.95 | 0.46 | 0.53 | 2.94 | 26.60 | 2.78 |
| Task Orientation | 0.89 | 0.93 | 0.39 | 0.47 | 2.36 | 31.68 | 2.22 |
| Investigation | 0.94 | 0.95 | 0.38 | 0.46 | 2.45 | 24.46 | 2.86 |
| Cooperation | 0.92 | 0.95 | 0.41 | 0.47 | 2.80 | 30.64 | 7.48 |
| Equity | 0.95 | 0.98 | 0.37 | 0.45 | 3.17 | 32.52 | 3.10 |
| Differentiation | 0.82 | 0.86 | 0.22 | 0.23 | 3.12 | 24.47 | 2.93 |
| Computer Usage | 0.88 | 0.93 | 0.20 | 0.21 | 6.50 | 24.33 | 4.72 |
| Young Adult Ethos | 0.94 | 0.97 | 0.37 | 0.45 | 3.04 | 33.18 | 2.76 |

Note. Scale means and standard deviations were computed using item class means.

Discriminant validity (using the mean correlation of a scale with the remaining nine scales as an index) ranged from 0.20 for the Computer Usage scale to 0.46 for the Involvement scale with the individual as the unit of analysis and from 0.21 to 0.53 with the class as the unit of analysis (see Table 3). These values suggest that the TROFLEI's scales are distinct but tend to overlap. Given that the TROFLEI has 10 scales assessing classroom environment, this result is not surprising.

In order to establish whether the TROFLEI differentiates between classes, a one-way ANOVA with the individual student as the unit of analysis and class membership as the main effect was performed for each scale. The results of these analyses are shown in Table 3 and indicate that all 10 scales differentiated significantly between classes ($p < 0.001$). The η^2 statistic, which is a ratio of between to total sums of squares (Cohen and Cohen, 1975), indicated that the proportion of variance explained by class membership ranged from 14.39 per cent for the Task Orientation scale to 31.97 per cent for the Computer Usage scale. Table 3 also shows means and standard deviations for each scale.

CLUSTER ANALYSIS

A review of dendograms based on hierarchical cluster analysis indicated that a five cluster solution in which 279 of the 286 classes could be clustered was appropriate. These clusters accounted for 4,067 of the 4,146 students in the sample (98.1%). These five homogeneous groups (Clusters A, B, C, D and E) contained respectively 156 classes (2,122 students), 62 classes (1,077 students), 15 classes (181 students), 31 classes (546 students), and 15 classes (220 students). Figure 1 shows TROFLEI mean scores for these five clusters.

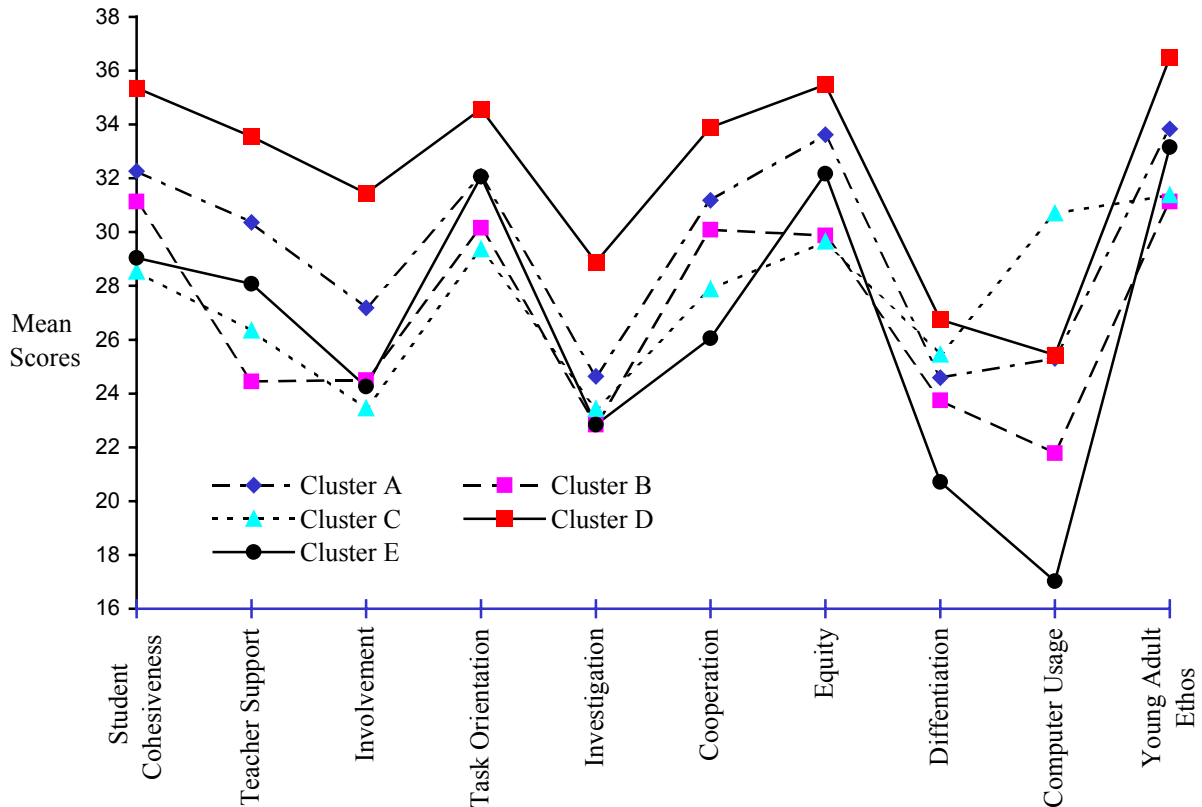


Figure 1. Mean scores for five clusters of students for 10 TROFLEI scales

In order to verify this five cluster solution, a multivariate analysis of variance (MANOVA) was performed on the data using the 10 TROFLEI scales as dependent variables and cluster membership as the grouping variable. The MANOVA analysis was significant with Wilks' lambda criterion of 0.003, $F(40,1006) = 22.8$ ($p < 0.001$). Univariate F tests for the effect of cluster grouping on each TROFLEI scale yielded the following results: Student Cohesiveness, $F(4,274) = 51.9$ ($p < 0.001$); Teacher Support, $F(4,274) = 123.5$ ($p < 0.001$); Involvement, $F(4,274) = 107.8$ ($p < 0.001$); Task Orientation, $F(4,274) = 44.0$ ($p < 0.001$); Investigation, $F(4,274) = 42.4$ ($p < 0.001$); Cooperation, $F(4,274) = 51.9$ ($p < 0.001$); Equity, $F(4,274) = 49.5$ ($p < 0.001$); Differentiation, $F(4,274) = 14.1$ ($p < 0.001$); Computer Usage, $F(4,274) = 34.5$ ($p < 0.001$) and Young Adult Ethos, $F(4,274) = 39.9$ ($p < 0.001$). Tukey's post hoc procedure revealed that 77 of 100 comparisons of cluster group means were significant ($p < 0.05$). These analyses confirm that this cluster solution separated the classes into five distinct groups.

Consideration of Figure 1 indicated the following findings: scale means for Cluster D were the highest on all scales apart from Computer Usage. Clusters C and E has low scale means on most scales. The exception to this pattern was Computer Usage for Cluster C which was the highest for the five groups. In fact, eight Cluster C scale means and nine Cluster E scale means were below the respective means for the full sample. However, Clusters C and E can be distinguished by the

means for one scale: Computer Usage for which Cluster E had the lowest mean and Cluster C the highest mean.

Although all 10 Cluster B means were below their respective full sample scale mean, there were only two scales for which the Cluster B mean was the lowest: Teacher Support and Involvement. Cluster A constituted 156 of the 279 clustered classes. While its scale means were all above the full sample mean, none of the Cluster A scale means was more than 0.36 standard deviations above the respective full sample scale mean. In general, Cluster D classrooms had the most positive environments. Clusters D and E has the poorest environments. Cluster A classrooms were above average but they were not the most positive environments in the sample. Cluster B classes were below average but they were not the poorest environments. It is noteworthy that only 31 of the 279 classes fell into Cluster D and that Clusters C and E had a total of only 30 classes.

DISCUSSION

This research has shown that the TROFLEI has very sound psychometric properties. Its scales have very good internal consistency reliability and it has very sound factorial validity. Its overall structure compares favourably with classroom environment instruments developed over the past two decades and reported in reviews of classroom environment research by Dorman (2002), Fraser (1998a, 1998b, 2002). Of significance is the fact that the TROFLEI assesses contemporary dimensions of classroom environments. This reflects the view that classroom environments are dynamic rather than static entities and that instrumentation needs to be continually reviewed. It is now customary to validate context-specific instruments rather than simply use an instrument 'off the shelf' when conducting classroom environment research.

The results of the cluster analysis raise three important issues. First, although it is possible to establish typologies of classes through cluster analysis, little research has been conducted in this area. Typically, classroom environment research of the past 35 years has used large student samples and employed quantitative data collection methods. Cluster analysis provides a very useful way of achieving parsimony when such data are analysed. Each of the clusters identified in this study can be assigned a descriptor that encapsulates the main characteristics of that cluster. For this study, the five acceptable descriptors are: Cluster A: safe, conservative; Cluster B: non-technological teacher-centred; Cluster C: contested technological; Cluster D: exemplary; Cluster E: contested non-technological.

Second, only 11 per cent of classes (31/279) were assigned to Cluster D – the exemplary environments cluster. This is a disappointing result and suggests that there is considerable room for improvement in the environments of many of the remaining 248 classes. It is also noteworthy that Computer Usage was the only scale for which Cluster D did not have the highest cluster score. Computer Usage had the lowest mean for the full sample but, as the profiles of Figure 1 indicate, it had the highest spread of results. There is considerable variation in Computer Usage scores and this suggests that there are divergent ways in which computers are being employed in schools. One of the schools in the sample was established with the aim of integrating technology into all aspects of the school including administration, teaching and learning. Of the 31 classes in Cluster D, only four classes were from the 115 classes surveyed in this school. It is noteworthy that 95 of the 115 classes from this school were in Clusters A and B, neither of which scored the highest on Computer Usage. It would appear that students' perceptions of Computer Usage are not consistent with the rhetoric of the school in terms of the integration of computers into everyday school events.

Finally, it is desirable that research builds upon and extends the findings of this cluster analysis. To unravel the complexities of classroom environments, the exemplary classrooms of Cluster D should be studied in more detail. Through observation and intensive, focussed qualitative research

it would be possible to ascertain the key behaviours of teacher and students in these classrooms. Such findings would be of particular benefit in pre-service teacher education courses and in-service professional development for practising teachers.

CONCLUSION

This study has reported the use of the TROFLEI to identify homogeneous clusters of classes from a large sample of secondary school classrooms. The TROFLEI is a relatively new classroom environment instrument developed within the traditions of high inference measurement which have been the dominant methodology of learning environment research for the past 35 years. Validation data attested to the TROFLEI's sound structure. It is desirable that further research on classroom environment typologies be conducted so that a body of literature can be firmly established.

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