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CLASSROOM ENVIRONMENT INSTRUMENTS: DEVELOPMENT, VALIDITY AND APPLICATIONS

ABSTRACT. Few fields of educational research have such a rich diversity of valid, economical and widely-applicable assessment instruments as does the field of learning environments. This article describes nine major questionnaires for assessing student perceptions of classroom psychosocial environment (the *Learning Environment Inventory*, *Classroom Environment Scale*, *Individualised Classroom Environment Questionnaire*, *My Class Inventory*, *College and University Classroom Environment Inventory*, *Questionnaire on Teacher Interaction*, *Science Laboratory Environment Inventory*, *Constructivist Learning Environment Survey* and *What Is Happening In This Class*) and reviews the application of these instruments in 12 lines of past research (focusing on associations between outcomes and environment, evaluating educational innovations, differences between student and teacher perceptions, whether students achieve better in their preferred environment, teachers' use of learning environment perceptions in guiding improvements in classrooms, combining quantitative and qualitative methods, links between different educational environments, cross-national studies, the transition from primary to high school, and incorporating educational environment ideas into school psychology, teacher education and teacher assessment).

KEY WORDS: assessment, classroom environment, evaluation, student perceptions, validity

In the 30 years since the pioneering use of classroom environment assessments in an evaluation of Harvard Project Physics (Walberg and Anderson, 1968), the field of learning environments has undergone remarkable growth, diversification and internationalisation. Several literature reviews (Fraser, 1986, 1994, 1998; Fraser and Walberg, 1991) place these developments into historical perspective and show that learning environment assessments have been used as a source of dependent and independent variables in a rich variety of research applications spanning many countries. The assessment of learning environments and research applications have involved a variety of quantitative and qualitative methods, and an important accomplishment within the field has been the productive combination of quantitative and qualitative research methods (Tobin and Fraser, 1998).

A historical look at the field of learning environment over the past few decades shows that a striking feature is the availability of a variety of economical, valid and widely-applicable questionnaires that have been

developed and used for assessing students' perceptions of classroom environment. Few fields in education can boast the existence of such a rich array of validated and robust instruments which have been used in so many research applications. Because this existence of a rich diversity of classroom environment instruments is a hallmark of the field, this article in the inaugural issue of *Learning Environments Research* is devoted to making this valuable range of instruments readily available to wide audiences by describing nine major questionnaires and their past application in 12 lines of research.

Although using students' and teachers' perceptions to study classroom environments forms the focus of this article, this method can be contrasted with the external observer's direct observation and systematic coding of classroom communication and events (Brophy and Good, 1986). Another approach to studying educational environments involves application of the techniques of naturalistic inquiry, ethnography, case study or interpretive research (Erickson, 1998). In the method considered in detail in this article, defining the classroom environment in terms of the shared perceptions of the students and teachers has the dual advantage of characterising the setting through the eyes of the participants themselves and capturing data which the observer could miss or consider unimportant. Students are at a good vantage point to make judgements about classrooms because they have encountered many different learning environments and have enough time in a class to form accurate impressions. Also, even if teachers are inconsistent in their day-to-day behaviour, they usually project a consistent image of the long-standing attributes of classroom environment.

This article falls into four main parts. First, nine specific instruments for assessing perceptions of classroom environment are described. Second, some important developments with classroom environment instruments are outlined (preferred forms, distinction between personal and class forms). Third, the validation of classroom environment scales is discussed. Fourth, an overview is given of numerous lines of past research involving classroom environment assessments, including studies which focus on associations between outcomes and environment, evaluation of educational innovations, differences between student and teacher perceptions, whether students achieve better in their preferred environment, teachers' use of classroom environment instruments in practical attempts to improve their own classrooms, combining quantitative and qualitative methods, school psychology, links between educational environments, cross-national studies, transition from primary to secondary schooling, teacher education and teacher assessment.

1. Instruments for Assessing Classroom Environment

This section describes the following historically important and contemporary instruments: *Learning Environment Inventory* (LEI); *Classroom Environment Scale* (CES); *Individualised Classroom Environment Questionnaire* (ICEQ); *My Class Inventory* (MCI); *College and University Classroom Environment Inventory* (CUCEI); *Questionnaire on Teacher Interaction* (QTI); *Science Laboratory Environment Inventory* (SLEI); *Constructivist Learning Environment Survey* (CLES); and *What Is Happening In This Class* (WIHIC) questionnaire. In addition, several other instruments are discussed towards the end of this section. Table I shows the name of each scale in the nine instruments, the level (primary, secondary, higher education) for which each instrument is suited, the number of items contained in each scale, and the classification of each scale according to Moos's (1974) scheme for classifying human environments. Moos's three basic types of dimensions are *Relationship Dimensions* (which identify the nature and intensity of personal relationships within the environment and assess the extent to which people are involved in the environment and support and help each other), *Personal Development Dimensions* (which assess basic directions along which personal growth and self-enhancement tend to occur) and *System Maintenance and System Change Dimensions* (which involve the extent to which the environment is orderly, clear in expectations, maintains control and is responsive to change).

1.1. *Learning Environment Inventory (LEI)*

The initial development and validation of the LEI began in the late 1960s in conjunction with evaluation and research related to Harvard Project Physics (Fraser et al., 1982; Walberg and Anderson, 1968). The final version contains 105 statements (seven per scale) descriptive of typical school classes. The respondent expresses degree of agreement with each statement using the four response alternatives of Strongly Disagree, Disagree, Agree and Strongly Agree. The scoring direction is reversed for some items. A typical item in the Cohesiveness scale is: 'All students know each other very well' and in the Speed scale is: 'The pace of the class is rushed'.

1.2. *Classroom Environment Scale (CES)*

The CES (Fisher and Fraser, 1983b; Moos, 1979; Moos and Trickett, 1987) grew out of a comprehensive program of research involving perceptual measures of a variety of human environments including psychiatric hos-

TABLE I

Overview of scales contained in nine classroom environment instruments (LEI, CES, ICEQ, MCI, CUCEI, QTI, SLEI, CLES and WIHIC)

Instrument	Level	Items per scale	Scales classified according to Moos's scheme		
			Relationship dimensions	Personal development dimensions	System maintenance and change dimensions
Learning Environment Inventory (LEI)	Secondary	7	Cohesiveness Friction Favouritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material environment Goal direction Disorganisation Democracy
Classroom Environment Scale (CES)	Secondary	10	Involvement Affiliation Teacher support	Task orientation Competition	Order and organisation Rule clarity Teacher control Innovation
Individualised Classroom Environment Questionnaire (ICEQ)	Secondary	10	Personalisation Participation	Independence Investigation	Differentiation
My Class Inventory (MCI)	Elementary	6–9	Cohesiveness Friction Satisfaction	Difficulty Competitiveness	
College and University Classroom Environment Inventory (CUCEI)	Higher education	7	Personalisation Involvement Student cohesiveness Satisfaction	Task orientation	Innovation Individualisation
Questionnaire on Teacher Interaction (QTI)	Secondary/ Primary	8–10	Helpful/friendly Understanding Dissatisfied Admonishing		Leadership Student responsibility and freedom Uncertain Strict
Science Laboratory Environment Inventory (SLEI)	Upper Secondary/ Higher education	7	Student cohesiveness	Open-Endedness Integration	Rule clarity Material environment
Construcitivist Learning Environment Survey (CLES)	Secondary	7	Personal relevance Uncertainty	Critical voice Shared control	Student negotiation
What Is Happening In This Classroom (WIHIC)	Secondary	8	Student cohesiveness Teacher support Involvement	Investigation Task orientation Cooperation	Equity

pitals, prisons, university residences and work milieus (Moos, 1974). The final published version contains nine scales with ten items of True-False response format in each scale. Published materials include a test manual, a questionnaire, an answer sheet and a transparent hand scoring key. Typical items in the CES are: "The teacher takes a personal interest in the students" (Teacher Support) and "There is a clear set of rules for students to follow" (Rule Clarity).

1.3. *Individualised Classroom Environment Questionnaire (ICEQ)*

The ICEQ assesses those dimensions which distinguish individualised classrooms from conventional ones. The initial development of the ICEQ was guided by: the literature on individualised, open and inquiry-based education; extensive interviewing of teachers and secondary school students; and reactions to draft versions sought from selected experts, teachers and junior high school students. The final published version of the ICEQ (Fraser, 1990) contains 50 items altogether, with an equal number of items belonging to each of the five scales. Each item is responded to on a five-point scale with the alternatives of Almost Never, Seldom, Sometimes, Often and Very Often. The scoring direction is reversed for many of the items. Typical items are "The teacher considers students' feelings" (Personalisation) and "Different students use different books, equipment and materials" (Differentiation). The copyright arrangement gives permission to purchasers to make an unlimited number of copies of the questionnaires and response sheets.

1.4. *My Class Inventory (MCI)*

The LEI was simplified to form the MCI for use among children aged 8–12 years (Fisher and Fraser, 1981; Fraser et al., 1982; Fraser and O'Brien, 1985). Although the MCI was developed originally for use at the primary school level, it also has been found to be useful with students in the junior high school, especially those with limited reading skills. The MCI differs from the LEI in four important ways. First, in order to minimise fatigue among younger children, the MCI contains only five of the LEI's original 15 scales. Second, item wording was simplified to enhance readability. Third, the LEI's four-point response format was reduced to a two-point (Yes-No) response format. Fourth, students answer on the questionnaire itself instead of on a separate response sheet to avoid errors in transferring responses from one place to another. The final form of the MCI contains 38 items altogether, although Fraser and O'Brien (1985) have developed

a short 25-item version. Typical items are: "Children are always fighting with each other" (Friction) and "Children seem to like the class" (Satisfaction). Goh et al. (1995) changed the MCI's Yes-No response format to a three-point response format (Seldom, Sometimes and Most of the Time) in a modified version of the MCI which includes a Task Orientation scale.

1.5. *College and University Classroom Environment Inventory (CUCEI)*

Although some notable prior work has focused on the institutional-level or school-level environment in colleges and universities, surprisingly little work has been done in higher education classrooms which is parallel to the traditions of classroom environment research at the secondary and primary school levels. Consequently, the CUCEI was developed for use in small classes (say up to 30 students) sometimes referred to as 'seminars' (Fraser and Treagust, 1986; Fraser et al., 1986). The final form of the CUCEI contains seven seven-item scales. Each item has four responses (Strongly Agree, Agree, Disagree, Strongly Disagree) and the polarity is reversed for approximately half of the items. Typical items are: "Activities in this class are clearly and carefully planned" (Task Orientation) and "Teaching approaches allow students to proceed at their own pace" (Individualisation).

1.6. *Questionnaire on Teacher Interaction (QTI)*

Research which originated in The Netherlands focuses on the nature and quality of interpersonal relationships between teachers and students (Wubbels and Brekelmans, 1998; Wubbels and Levy, 1993). Drawing upon a theoretical model of proximity (cooperation-opposition) and influence (dominance-submission), the QTI was developed to assess student perceptions of eight behaviour aspects. Each item has a five-point response scale ranging from Never to Always. Typical items are "She/he gives us a lot of free time" (Student Responsibility and Freedom behaviour) and "She/he gets angry" (Admonishing behaviour). Cross-validation and comparative work with the QTI has been completed at various grade levels in the USA (Wubbels and Levy, 1993), Australia (Fisher, Henderson et al., 1995), Singapore (Goh and Fraser, 1996) and Brunei (Riah et al., 1997), and a more economical 48-item version has been developed and validated (Goh and Fraser, 1996).

1.7. *Science Laboratory Environment Inventory (SLEI)*

Because of the importance of laboratory settings in science education, an instrument specifically suited to assessing the environment of science laboratory classes at the senior high school or higher education levels was developed (Fraser et al., 1995; Fraser and McRobbie, 1995). The SLEI has five scales (each with seven items) and the five response alternatives are Almost Never, Seldom, Sometimes, Often and Very Often. Typical items are "I use the theory from my regular science class sessions during laboratory activities" (Integration) and "We know the results that we are supposed to get before we commence a laboratory activity" (Open-Endedness). The SLEI was field tested and validated simultaneously with a sample of 5447 students in 269 classes in six different countries (the USA, Canada, England, Israel, Australia and Nigeria), and cross-validated with 1594 Australian students in 92 classes (Fraser and McRobbie, 1995), 489 senior high school biology students in Australia (Fisher, Henderson et al., 1997) and 1592 Grade 10 chemistry students in Singapore (Wong and Fraser, 1995).

1.8. *Constructivist Learning Environment Survey (CLES)*

According to the constructivist view, meaningful learning is a cognitive process in which individuals make sense of the world in relation to the knowledge which they already have constructed, and this sense-making process involves active negotiation and consensus building. The CLES (Taylor et al., 1995; Taylor et al., 1997) was developed to assist researchers and teachers to assess the degree to which a particular classroom's environment is consistent with a constructivist epistemology, and to assist teachers to reflect on their epistemological assumptions and reshape their teaching practice. The CLES has 36 items with five response alternatives ranging from Almost Never to Almost Always. Typical items are "I help the teacher to decide what activities I do" (Shared Control) and "Other students ask me to explain my ideas" (Student Negotiation).

1.9. *What Is Happening In This Class (WIHIC) Questionnaire*

The WIHIC questionnaire brings parsimony to the field of classroom environment by combining modified versions of the most salient scales from a wide range of existing questionnaires with additional scales that accommodate contemporary educational concerns (e.g. equity and constructivism). The original 90-item nine-scale version was refined by both statistical

analysis of data from 355 junior high school science students, and extensive interviewing of students about their views of their classroom environments in general, the wording and salience of individual items and their questionnaire responses (Fraser et al., 1996). Only 54 items in seven scales survived these procedures, although this set of items was expanded to 80 items in eight scales for the field testing of the second version of the WIHIC. Whereas an Australian sample of 1081 students in 50 classes responded to the original English version, a Taiwanese sample of 1879 students in 50 classes responded to a Chinese version that had undergone careful procedures of translation and back translation (Huang et al., 1998). This led to a final form of the WIHIC containing the seven eight-item scales, which also has been used successfully among 2310 high school students in Singapore (Chionh and Fraser, 1998).

1.10. *Other Instruments*

Other studies have drawn on scales and items in existing questionnaires to develop modified instruments which better suit particular research purposes and research contexts. For a study of the classroom environment of Catholic schools, Dorman et al. (1997) developed a 66-item instrument which drew on the CES, CUCEI and ICEQ but made important modifications. The seven scales in this study (Student Application, Interactions, Cooperation, Task Orientation, Order and Organisation, Individualisation and Teacher Control) were validated using a sample of 2211 Grade 9 and 12 students in 104 classes.

In evaluations of computer-assisted learning, Maor and Fraser (1996) and Teh and Fraser (1994, 1995b) drew on existing scales in developing specific-purpose instruments. Maor and Fraser developed a five-scale classroom environment instrument (assessing Investigation, Open-Endedness, Organisation, Material Environment and Satisfaction) based on the LEI, ICEQ and SLEI and validated it with a sample of 120 Grade 11 students in Australia. Teh and Fraser developed a four-scale instrument to assess Gender Equity, Investigation, Innovation and Resource Adequacy, and validated it among 671 high school geography students in Singapore.

Whereas most classroom environment instruments focus on general psychosocial characteristics, Woods and Fraser (1995) developed a questionnaire to assess student perceptions of specific teacher behaviours. The *Classroom Interaction Patterns Questionnaire* (CIPQ) assesses teaching style with the scales of Praise and Encouragement, Open Questioning, Lecture and Direction, Individual Work, Discipline and Management, and

Group Work. Successive versions were field tested with a total of 1470 Grade 8–10 students in 62 classes in Western Australia.

Based partly on existing instruments, Fisher and Waldrip (1997) developed a questionnaire to assess culturally sensitive factors of learning environments. The 40-item *Cultural Learning Environment Questionnaire* (CLEQ) assesses students' perceptions of Equity, Collaboration, Risk Involvement, Competition, Teacher Authority, Modelling, Congruence and Communication. Administration of the new questionnaire to 3031 secondary science students in 135 classes in Australia provided support for the internal consistency reliability and factorial validity of the CLEQ.

Jegede et al. (1995) developed the *Distance and Open Learning Environment Scale* (DOLES) for use among university students studying by distance education. The DOLES has the five core scales of Student Cohesiveness, Teacher Support, Personal Involvement and Flexibility, Task Orientation and Material Environment, and Home Environment, as well as the two optional scales of Study Centre Environment and Information Technology Resources. Administration of the DOLES to 660 university students provided support for its internal consistency reliability and factor structure.

2. SOME IMPORTANT DEVELOPMENTS WITH CLASSROOM ENVIRONMENT INSTRUMENTS

A distinctive feature of most of the instruments in Table I is that they have, not only a form to measure perceptions of 'actual' or experienced classroom environment, but also another form to measure perceptions of 'preferred' or ideal classroom environment. The preferred forms are concerned with goals and value orientations and measure perceptions of the classroom environment ideally liked or preferred. Although item wording is similar for actual and preferred forms, slightly different instructions for answering each are used. For example, an item in the actual form such as "There *is* a clear set of rules for students to follow" would be changed in the preferred form to "There *would be* a clear set of rules for students to follow".

Fraser and Tobin (1991) point out that there is potentially a problem with nearly all existing classroom environment instruments when they are used to identify differences between subgroups within a classroom (e.g. males and females) or in the construction of case studies of individual students. The problem is that items elicit an individual student's perceptions of the class as a whole, as distinct from a student's perceptions of his/her own role within the classroom. For example, items in the traditional class

form might seek students' opinions about whether "*the work of the class is difficult*" or whether "*the teacher is friendly towards the class*". In contrast, a personal form of the same items would seek opinions about whether "*I find the work of the class difficult*" or whether "*the teacher is friendly towards me*". Confounding could have arisen in past studies which employed the class form because, for example, males could find a class less difficult than females, yet males and females still could agree when asked for their opinions about the class as a whole. The distinction between personal and class forms is consistent with Stern et al.'s (1956) terms of 'private' beta press, the idiosyncratic view that each person has of the environment, and 'consensual' beta press, the shared view that members of a group hold of the environment.

When Fraser et al. (1995) used parallel class and personal forms of both an actual and preferred version of the SLEI, students' scores on the class form were found to be systematically more favourable than their scores on the personal form. As hypothesised, gender differences in perceptions were somewhat larger on the personal form than on the class form. Although a study of associations between student outcomes and their perceptions of the science laboratory environment revealed that the magnitudes of associations were comparable for class and personal forms, commonality analyses showed that each form accounted for appreciable amounts of outcome variance which was independent of that explained by the other form (Fraser and McRobbie, 1995). This finding justifies the decision to evolve separate class and personal forms because they appear to measure different, albeit overlapping, aspects of the science laboratory classroom environment.

3. VALIDATION OF SCALES

Table II provides a summary of a limited amount of statistical information for the nine instruments (LEI, CES, ICEQ, MCI, CUCEI, QTI, SLEI, CLES and WIHIC) considered previously. Attention is restricted to the student actual form and to the use of the individual student as the unit of analysis. Table II provides information about each scale's internal consistency reliability (alpha coefficient) and discriminant validity (using the mean correlation of a scale with the other scales in the same instrument as a convenient index), and the ability of a scale to differentiate between the perceptions of students in different classrooms (significance level and *eta*^{2} statistic from ANOVAs). Statistics are based on 1048 students for the LEI, except for discriminant validity data which are based on 149 class means (Fraser et al., 1982), 1083 students for the CES (Fisher and Fraser,

1983b), 1849 students for the ICEQ (Fraser, 1990), 2305 students for the MCI (Fisher and Fraser, 1981), 372 students for the CUCEI (Fraser and Treagust, 1986), 3994 high school science and mathematics students for the QTI (Fisher, Fraser et al., 1997), 3727 senior high school students for the SLEI (Fraser et al., 1995) and 1081 high school science students for both the CLES and WIHIC (Huang et al., 1998).

4. RESEARCH INVOLVING CLASSROOM ENVIRONMENT INSTRUMENTS

In order to illustrate the many and varied applications of classroom environment instruments, this section considers 12 types of past research which focus on (1) associations between student outcomes and environment, (2) evaluation of educational innovations, (3) differences between students' and teachers' perceptions of the same classrooms, (4) whether students achieve better when in their preferred environments, (5) teachers' practical attempts to improve their classroom climates, (6) combining qualitative and quantitative methods, (7) school psychology, (8) links between educational environments, (9) cross-national studies, (10) transition from primary to secondary education, (11) teacher education and (12) teacher assessment.

4.1. *Associations Between Student Outcomes and Environment*

The strongest tradition in past classroom environment research has involved investigation of associations between students' cognitive and affective learning outcomes and their perceptions of psychosocial characteristics of their classrooms. Fraser's (1994) tabulation of 40 past studies shows that associations between outcome measures and classroom environment perceptions have been replicated for a variety of cognitive and affective outcome measures, a variety of classroom environment instruments and a variety of samples (ranging across numerous countries and grade levels). Using the SLEI, associations with students' cognitive and affective outcomes were found for a sample of approximately 80 senior high school chemistry classes in Australia (Fraser and McRobbie 1995; McRobbie and Fraser, 1993), 489 senior high school biology students in Australia (Fisher, Henderson et al., 1997) and 1592 Grade 10 chemistry students in Singapore (Wong and Fraser, 1996). Using an instrument suited for computer-assisted instruction classrooms, Teh and Fraser (1995a) found associations between classroom environment, achievement and attitudes

TABLE II

Internal consistency (alpha reliability), discriminant validity (mean correlation of a scale with other scales), and ANOVA results for class membership differences (eta^2 statistic and significance level) for student actual form of nine instruments using individual as unit of analysis.

Scale	Alpha rel.	Mean correl. with other scales	ANOVA results (eta^2)
Learning Environment Inventory (LEI) ($n = 1048$ students; $n = 149$ classes)			
Cohesiveness	0.69	0.14	_[a]
Diversity	0.54	0.16	–
Formality	0.76	0.18	–
Speed	0.70	0.17	–
Material Environment	0.56	0.24	–
Friction	0.72	0.36	–
Goal Direction	0.85	0.37	–
Favouritism	0.78	0.32	–
Difficulty	0.64	0.16	–
Apathy	0.82	0.39	–
Democracy	0.67	0.34	–
Cliqueness	0.65	0.33	–
Satisfaction	0.79	0.39	–
Disorganisation	0.82	0.40	–
Competitiveness	0.78	0.08	–
Classroom Environment Scale (CES) ($n = 1083$ students)			
Involvement	0.70	0.40	0.29*
Affiliation	0.60	0.24	0.21*
Teacher Support	0.72	0.29	0.34*
Task Orientation	0.58	0.23	0.25*
Competition	0.51	0.09	0.18*
Order and Organisation	0.75	0.29	0.43*
Rule Clarity	0.63	0.29	0.21*
Teacher Control	0.60	0.16	0.27*
Innovation	0.52	0.19	0.26*
Individualised Classroom Environment Questionnaire (ICEQ) ($n = 1849$ students)			
Personalisation	0.79	0.28	0.31*
Participation	0.70	0.27	0.21*
Independence	0.68	0.07	0.30*
Investigation	0.71	0.21	0.20*
Differentiation	0.76	0.10	0.43*
My Class Inventory (MCI) ($n = 2305$ students)			
Cohesiveness	0.67	0.20	0.21*
Friction	0.67	0.26	0.31*
Difficulty	0.62	0.14	0.18*
Satisfaction	0.78	0.23	0.30*
Competitiveness	0.71	0.10	0.19*

[a]This statistic is not available for the LEI.

TABLE II

Continued.

Scale	Alpha rel.	Mean correl. with other scales	ANOVA results (eta^2)
College and University Classroom Environment Inventory (CUCEI) ($n = 372$ students)			
Personalisation	0.75	0.46	0.35*
Involvement	0.70	0.47	0.40*
Student Cohesiveness	0.90	0.45	0.47*
Satisfaction	0.88	0.45	0.32*
Task Orientation	0.75	0.38	0.43*
Innovation	0.81	0.46	0.41*
Individualisation	0.78	0.34	0.46*
Questionnaire on Teacher Interaction (QTI) ($n = 3994$ students)			
Leadership	0.82	_[b]	0.33*
Helping/Friendly	0.88	–	0.35*
Understanding	0.85	–	0.32*
Student Responsibility/Freedom	0.66	–	0.26*
Uncertain	0.72	–	0.22*
Dissatisfied	0.80	–	0.23*
Admonishing	0.76	–	0.31*
Strict	0.63	–	0.23*
Science Laboratory Environment Inventory (SLEI) ($n = 3727$ students)			
Student Cohesiveness	0.77	0.34	0.21*
Open-Endedness	0.70	0.07	0.19*
Integration	0.83	0.37	0.23*
Rule Clarity	0.75	0.33	0.21*
Material Environment	0.75	0.37	0.21*
Constructivist Learning Environment Survey (CLES) ($n = 1081$ students)			
Personal Relevance	0.88	0.43	0.16*
Uncertainty	0.76	0.44	0.14*
Critical Voice	0.85	0.31	0.14*
Shared Control	0.91	0.41	0.17*
Student Negotiation	0.89	0.40	0.14*
What Is Happening In This Classroom (WIHIC) ($n = 1081$ students)			
Student Cohesiveness	0.81	0.37	0.09*
Teacher Support	0.88	0.43	0.15*
Involvement	0.84	0.45	0.10*
Investigation	0.88	0.41	0.15*
Task Orientation	0.88	0.42	0.15*
Cooperation	0.89	0.45	0.12*
Equity	0.93	0.46	0.13*

[b]This statistic is not relevant for the QTI.

$p < 0.01$.

among a sample of 671 high school geography students in 24 classes in Singapore. Using the QTI, associations between student outcomes and perceived patterns of teacher-student interaction were reported for samples of 489 senior high school biology students in Australia (Fisher, Henderson et al., 1995), 3994 high school science and mathematics students in Australia (Fisher, Fraser et al., 1997) and 1512 primary school mathematics students in Singapore (Goh et al., 1995).

While many past learning environment studies have employed techniques such as multiple regression analysis, few have used multilevel analysis (Bock, 1989; Bryk and Raudenbush, 1992; Goldstein, 1987), which takes cognisance of the hierarchical nature of classroom settings. Recently, however, two studies compared the results from multiple regression analysis with those from an analysis involving the hierarchical linear model. In Wong et al.'s (1997) study involving 1592 Grade 10 students in 56 chemistry classes in Singapore, associations were investigated between three student attitude measures and a modified version of the SLEI. In Goh et al.'s (1995) study with 1512 Grade 5 mathematics students in 39 classes in Singapore, scores on a modified version of the MCI were related to student achievement and attitude. Most of the statistically significant results from the multiple regression analyses were replicated in the HLM analyses, as well as being consistent in direction.

In a meta-analysis involving 734 correlations from 12 studies involving 823 classes, eight subject areas, 17,805 students and four nations (Haertel et al., 1981), learning post-test scores and regression-adjusted gains were consistently and strongly associated with cognitive and affective learning outcomes, although correlations were generally higher in samples of older students and in studies employing classes or schools (in contrast to individual students) as the units of statistical analysis. In particular, better achievement on a variety of outcome measures was found consistently in classes perceived as having greater Cohesiveness, Satisfaction and Goal Direction and less Disorganisation and Friction.

Psychosocial learning environment is one factor in Walberg's (1981) multi-factor psychological model of educational productivity, which holds that learning is a function of student age, ability and motivation; of quality and quantity of instruction; and of the psychosocial environments of the home, the classroom, the peer group and the mass media. In principle, any factor at a zero-point results in zero learning; thus either zero motivation or zero time for instruction results in zero learning. Moreover, it does less good to raise a factor that already is high than to improve one that currently is the main constraint to learning. Empirical probes of the educational productivity model involved extensive research syntheses involving the

correlations of learning with the factors in the model (Fraser et al., 1987; Walberg, 1986) and secondary analyses of large data bases collected as part of the National Assessment of Educational Achievement (Walberg, 1986) and National Assessment of Educational Progress (Walberg et al., 1986). Classroom and school environment was found to be a strong predictor of both achievement and attitudes even when a comprehensive set of other factors was held constant.

4.2. *Evaluation of Educational Innovations*

Classroom environment instruments can be used as a source of process criteria in the evaluation of educational innovations. An evaluation of the Australian Science Education Project (ASEP) revealed that, in comparison with a control group, ASEP students perceived their classrooms as being more satisfying and individualised and having a better material environment (Fraser, 1979). The significance of this evaluation is that classroom environment variables differentiated revealingly between curricula, even when various outcome measures showed negligible differences. Recently, the incorporation of a classroom environment instrument within an evaluation of the use of a computerised database revealed that students perceived that their classes became more inquiry oriented during the use of the innovation (Maor and Fraser, 1996). Similarly, in Singapore, classroom environment measures were used as dependent variables in evaluations of computer-assisted learning (Teh and Fraser, 1994) and computer application courses for adults (Khoo and Fraser, 1997). In an evaluation of an urban systemic reform initiative in the USA, use of the CLES painted a disappointing picture in terms of a lack of success in achieving the constructivist-oriented reform of science education (Dryden and Fraser, 1996).

4.3. *Differences Between Student and Teacher Perceptions of Actual and Preferred Environment*

An investigation of differences between students and teachers in their perceptions of the same actual classroom environment and of differences between the actual environment and that preferred by students or teachers was reported by Fisher and Fraser (1983a) using the ICEQ in Australia with a sample of 116 classes for the comparisons of student actual with student preferred scores and a subsample of 56 of the teachers of these classes for contrasting teachers' and students' scores. Students preferred a more positive classroom environment than was actually present for all five

environment dimensions. Also, teachers perceived a more positive class-
room environment than did their students in the same classrooms on four of
the dimensions. These results replicate patterns emerging in other studies
in classrooms in the USA (Moos, 1979), Israel (Hofstein and Lazarowitz,
1986) and The Netherlands (Wubbels et al., 1991), and in other settings
such as hospital wards and work milieus (e.g. Moos, 1974).

4.4. *Do Students Achieve Better in Their Preferred Environment?*

Using both actual and preferred forms of educational environment instru-
ments permits exploration of whether students achieve better when there
is a higher similarity between the actual classroom environment and that
preferred by students (Fraser and Fisher, 1983a, 1983b). Using the ICEQ
with a sample of 116 class means, Fraser and Fisher predicted post-test
achievement from pretest performance, general ability, the five actual in-
dividualisation variables and five variables indicating actual-preferred in-
teraction. Overall, the findings suggested that actual-preferred congruence
(or person-environment fit) could be as important as individualisation *per
se* in predicting student achievement of affective and cognitive aims. The
practical implication is that class achievement of certain outcomes might
be enhanced by changing the actual classroom environment in ways which
make it more congruent with that preferred by the class.

4.5. *Teachers' Attempts to Improve Classroom Environments*

Feedback information based on student or teacher perceptions has been
employed in a five-step procedure as a basis for reflection upon, discus-
sion of, and systematic attempts to improve classroom environments at the
early childhood level (Fisher, Fraser et al., 1995), primary level (Fraser
and Deer, 1983), secondary level (Thorp et al., 1994; Woods and Fraser,
1996) and higher education level (Yarrow and Millwater, 1995; Yarrow
et al., 1997). First, all students in the class respond to the preferred form
of a classroom environment instrument first, while the actual form is ad-
ministered in the same time slot about a week later (assessment). Second,
the teacher is provided with feedback information derived from student
responses in the form of profiles representing the class means of students'
actual and preferred environment scores (feedback). These profiles permit
identification of the changes in classroom environment needed to reduce
major differences between the nature of the actual environment and that
preferred by students. Third, the teacher engages in private reflection and
informal discussion about the profiles in order to provide a basis for a

decision about whether an attempt would be made to change the environment in terms of some of the dimensions (reflection and discussion). The main criteria used for selection of dimensions for change are, first, that there should be a sizeable actual-preferred difference on that variable and, second, that the teacher should feel concerned about this difference and want to make an effort to reduce it. Fourth, the teacher introduces an intervention of approximately two months' duration in an attempt to change the classroom environment (intervention). For example, strategies used to enhance the dimension of Teacher Support could involve the teacher moving around the class more to mix with students, providing assistance to students and talking with them more than previously. Fifth, the student actual form of the scales is re-administered at the end of the intervention to see whether students are perceiving their classroom environments differently from before (reassessment).

Woods and Fraser (1995) used this basic approach to improving classroom environments with 16 teachers who used the actual and preferred forms of the Classroom Interaction Patterns Questionnaire to assess student perceptions of teacher behaviour (Praise and Encouragement, Open Questioning, Lecture and Direction, Individual Work, Discipline and Management, and Group Work). Whereas half of the teachers received feedback and attempted changes in their classrooms, the other half only administered the questionnaires. Teachers who received feedback, compared with the teachers who didn't receive feedback, were able to achieve more reductions in actual-preferred discrepancies on most classroom environment dimensions.

Yarrow et al. (1997) reported a study in which 117 preservice education teachers were introduced to the field of learning environment through being involved in action research aimed at improving their university teacher education classes and their 117 primary school classes during teaching practice. The CUCEI was used at the university level and the MCI was used at the primary level. Improvements in classroom environment were observed, and the preservice teachers generally valued both the inclusion of the topic of learning environment in their preservice programs and the opportunity to be involved in action research aimed at improving classroom environments.

4.6. *Combining Quantitative and Qualitative Methods*

Significant progress has been made towards the desirable goal of combining quantitative and qualitative methods within the same study in research on classroom learning environments (Fraser and Tobin, 1991; Tobin

and Fraser, 1998). For example, a team of 13 researchers was involved in over 500 hours of intensive classroom observation of 22 exemplary teachers and a comparison group of non-exemplary teachers (Fraser and Tobin, 1989). The main data collection methods were based on interpretive research methods and involved classroom observation, interviewing of students and teachers, and the construction of case studies. But, a distinctive feature was that the qualitative information was complemented by quantitative information obtained from questionnaires assessing student perceptions of classroom psychosocial environment. These instruments furnished a picture of life in exemplary teachers' classrooms as seen through the students' eyes. The study suggested that, first, exemplary and non-exemplary teachers could be differentiated in terms of the psychosocial environments of their classrooms as seen through their students' eyes and, second, exemplary teachers typically create and maintain environments that are markedly more favourable than those of non-exemplary teachers (Fraser and Tobin, 1989).

In a study which focused on the elusive goal of higher-level cognitive learning, six researchers intensively studied the Grade 10 science classes of two teachers (Peter and Sandra) over a ten-week period (Tobin et al., 1990). Each class was observed by several researchers, interviewing of students and teachers took place on a daily basis, and students' written work was examined. The study also involved quantitative information from questionnaires assessing student perceptions of classroom psychosocial environment. Students' perceptions of the learning environment within each class were consistent with the observers' field records of the patterns of learning activities and engagement in each classroom. For example, the high level of Personalisation perceived in Sandra's classroom matched the large proportion of time that she spent in small-group activities during which she constantly moved about the classroom interacting with students. The lower level of Personalisation perceived in Peter's class was associated partly with the larger amount of time spent in the whole-class mode and the generally public nature of his interactions with students.

Fraser's (1996) multilevel study of the learning environment incorporated a teacher-researcher perspective as well as the perspective of six university-based researchers. The research commenced with an interpretive study of a Grade 10 teacher's classroom at a school which provided a challenging learning environment in that many students were from working class backgrounds, some were experiencing problems at home, and others had English as a second language. Qualitative methods involved several of the researchers visiting this class each time it met over five weeks, using student diaries, and interviewing the teacher-researcher, stu-

dents, school administrators and parents. A video camera recorded activities for later analysis. Field notes were written during and soon after each observation, and team meetings took place three times per week. The qualitative component of the study was complemented by a quantitative component involving the use of a questionnaire which linked three levels: the class in which the interpretive study was undertaken; selected classes from within the school; and classes distributed throughout the same State. This enabled a judgement to be made about whether this teacher was typical of other teachers at her school, and whether the school was typical of other schools within the State. Some of the features identified as salient in this teacher's classroom environment were peer pressure and an emphasis on laboratory activities.

4.7. *School Psychology*

The field of psychosocial learning environment furnishes a number of ideas, techniques and research findings which could be valuable in school psychology. Traditionally, school psychologists have tended to concentrate heavily and sometimes exclusively on their roles in assessing and enhancing academic achievement and other valued learning outcomes. The field of classroom environment provides an opportunity for school psychologists and teachers to become sensitised to subtle but important aspects of classroom life, and to use discrepancies between students' perceptions of actual and preferred environment as a basis to guide improvements in classrooms (Burden and Fraser, 1993).

4.8. *Links Between Educational Environments*

Although most individual studies of educational environments in the past have tended to focus on a single environment, there is potential in simultaneously considering the links between and joint influence of two or more environments. For example, Marjoribanks (1991) shows how the environments of the home and school interact and codetermine school achievement, and Moos (1991) illustrates the links between school, home and parents' work environments. Although educational researchers have paid more attention to classroom environment research than to school environment research, desirable future directions include a greater emphasis on the school-level environment and the integration of classroom and school climate variables within the same study. An example of a study which has established associations between school and classroom environment is Dorman et al. (1997). In order to investigate whether the socio-cultural en-

vironment influences Nigerian students' learning of science, Jegede et al.,
(1994) developed and validated the *Socio-Cultural Environment Scale* to
assess students' perceptions of Authoritarianism, Goal Structure, African
World-View, Societal Expectations and Sacredness of Science with 600 se-
nior secondary students. Apparently, students' socio-cultural environment
in non-Western societies interacts with the classroom environment and
therefore can create a wedge between what is taught and what is learned.

4.9. *Cross-National Studies*

Educational research which crosses national boundaries offers much pro-
mise for generating new insights for at least two reasons (Fraser, 1997).
First, there usually is greater variation in variables of interest (e.g. teach-
ing methods, student attitudes) in a sample drawn from multiple countries
than from a one-country sample. Second, the taken-for-granted familiar
educational practices, beliefs and attitudes in one country can be exposed,
made 'strange' and questioned when research involves two countries. In
Huang et al.'s (1998) cross-national study, six Australian and seven Tai-
wanese researchers worked together on a study of learning environments.
The WIHIC was administered to 50 junior high school science classes in
Taiwan (1879 students) and Australia (1081 students). An English version
of the questionnaire was translated into Chinese, followed by an indepen-
dent back translation of the Chinese version into English again by team
members who were not involved in the original translation. Qualitative
data, involving interviews with teachers and students and classroom obser-
vations, were collected to complement the quantitative information and to
clarify reasons for patterns and differences in the means in each country.

The scales of Involvement and Equity had the largest differences in
means between the two countries, with Australian students perceiving each
scale more positively than students from Taiwan. Data from the question-
naires guided the collection of qualitative data. Student responses to indi-
vidual items were used to form an interview schedule to clarify whether
items had been interpreted consistently by students and to help to explain
differences in questionnaire scale means between countries. Classrooms
were selected for observations on the basis of the questionnaire data, and
specific scales formed the focus for observations in these classrooms. The
qualitative data provided valuable insights into the perceptions of students
in each of the countries, helped to explain some of the differences in the
means between countries, and highlighted the need for caution when inter-
preting differences between the questionnaire results from two countries
with cultural differences.

4.10. *Transition from Primary to High School*

There is considerable interest in the effects on early adolescents of the transition from primary school to the larger, less personal environment of the junior high school at this time of life. Midgley et al. (1991) reported a deterioration in the classroom environment when students moved from generally smaller primary schools to larger, departmentally-organised lower secondary schools, perhaps because of less positive student relations with teachers and reduced student opportunities for decision making in the classroom. Ferguson and Fraser's (1996) study of 1040 students from 47 feeder primary schools and 16 linked high schools in Australia also indicated that students perceived their high school classroom environments less favourably than their primary school classroom environments, but the transition experience was different for boys and girls and for different school size 'pathways'.

4.11. *Teacher Education*

Although the field of psychosocial learning environment provides a number of potentially valuable ideas and techniques for inclusion in teacher education programs, little progress has been made in incorporating these ideas into teacher education. Fraser (1993) reported some case studies of how classroom and school environment work has been used within pre-service and inservice teacher education to (1) sensitise teachers to subtle but important aspects of classroom life, (2) illustrate the usefulness of including classroom environment assessments as part of a teacher's overall evaluation/monitoring activities, (3) show how assessment of classroom environment can be used to facilitate practical improvements in classrooms and (4) provide a valuable source of feedback about teaching performance for the formative and summative evaluation of student teaching. It appears that information on student perceptions of the classroom learning environment during preservice teachers' field experience adds usefully to the information obtained from university supervisors, school-based cooperating teachers and student teacher self-evaluation (Duschl and Waxman, 1991).

4.12. *Teacher Assessment*

The Louisiana STAR (System for Teaching and Learning Assessment and Review) is a teacher assessment system which specifically includes learning environment dimensions among a set of four performance dimensions

(Ellett et al., 1989). The other three performance dimensions are Preparation, Planning and Evaluation (e.g. teaching methods, homework, assessment), Classroom and Behaviour Management (e.g. student engagement, monitoring student behaviour) and Enhancement of Learning (e.g. content accuracy, thinking skills, pace, feedback). With the STAR, multiple observers complete an assessment in 45 minutes by focusing on preparation and planning in addition to in-class performance, on student learning as well as teaching behaviour, on higher-level as well as lower-level student learning, and on differential provision for different children. Teachers who were effective in terms of the psychosocial learning environment dimension were found to encourage positive interpersonal relationships within a classroom environment in which students feel comfortable and accepted. The teacher, through verbal and non-verbal behaviours, modelled enthusiasm and interest in learning, included all students in learning activities and encouraged active involvement.

5. CONCLUSION

The major purpose of this chapter devoted to perceptions of psychosocial characteristics of classroom environments has been to make this exciting research tradition more accessible to wider audiences. In its portrayal of some of the most salient aspects of prior work, attention has been given to widely applicable instruments for assessing perceptions of classroom environment (including the Learning Environment Inventory, Classroom Environment Scale, Individualised Classroom Environment Questionnaire, My Class Inventory, College and University Classroom Environment Inventory, Questionnaire on Teacher Interaction, Science Laboratory Environment Inventory, Constructivist Learning Environment Survey, and the What Is Happening In This Classroom questionnaire). Also a review has been provided of several major lines of previous research (focusing on associations between outcomes and environment, evaluating educational innovations, differences between student and teacher perceptions, whether students achieve better in their preferred environment, teachers' use of learning environment perceptions in guiding improvements in classrooms, combining quantitative and qualitative methods, links between different educational environments, cross-national studies, the transition from primary to high school, and incorporating educational environment ideas into school psychology, teacher education and teacher assessment).

References

Bock, R.D. (Ed.). (1989). *Multilevel analysis of educational data.* San Diego, CA: Academic Press.

Brophy, J. & Good, T.L. (1986). Teacher behavior and student achievement. In M.C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed.; pp. 328–375). New York: Macmillan.

Bryk, A.S. & Raudenbush, S.W. (1992). *Hierarchical linear models: applications and data analysis method.* Newbury Park, CA: Sage.

Burden, R. & Fraser, B.J. (1993). Use of classroom environment assessments in school psychology: A British perspective. *Psychology in the Schools*, 30, 232–240.

Chionh, Y.H. & Fraser, B.J. (1998, April). *Validation of the 'What Is Happening In This Class' questionnaire.* Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Diego, CA.

Dorman, J.P., Fraser, B.J. & McRobbie, C.J. (1997). Relationship between school-level and classroom-level environments in secondary schools. *Journal of Educational Administration*, 35, 74–91.

Dryden, M. & Fraser, B.J. (1996, April). *Evaluating urban systemic reform using classroom learning environment instruments.* Paper presented at the annual meeting of the American Educational Research Association, New York.

Duschl, R.A. & Waxman, H.C. (1991). Influencing the learning environment of student teaching. In B.J. Fraser & H.J. Walberg (Eds.), *Educational environments: evaluation, antecedents and consequences* (pp. 255–270). London: Pergamon.

Ellett, C.D., Loup, K.S. & Chauvin, S.W. (1989). *System for Teaching and Learning Assessment and Review (STAR): Annotated guide to teaching and learning.* Baton Rouge, LA: Louisiana Teaching Internship and Teacher Evaluation Projects, College of Education, Louisiana State University.

Erickson, F. (1998). Qualitative research methods for science education. In B.J. Fraser & K.G. Tobin (Eds.), *International handbook of science education* (pp. 1155–1173). Dordrecht, The Netherlands: Kluwer.

Ferguson, P.D. & Fraser, B.J. (1996, April). *School size, gender, and changes in learning environment perceptions during the transition from elementary to high school.* Paper presented at the annual meeting of the American Educational Research Association, New York.

Fisher, D.L. & Fraser, B.J. (1981). Validity and use of My Class Inventory. *Science Education*, 65, 145–156.

Fisher, D.L. & Fraser, B.J. (1983a). A comparison of actual and preferred classroom environment as perceived by science teachers and students. *Journal of Research in Science Teaching*, 20, 55–61.

Fisher, D.L. & Fraser, B.J. (1983b). Validity and use of Classroom Environment Scale. *Educational Evaluation and Policy Analysis*, 5, 261–271.

Fisher, D.L., Fraser, B.J. & Bassett, J. (1995). Using a classroom environment instrument in an early childhood classroom. *Australian Journal of Early Childhood*, 20(3), 10–15.

Fisher, D.L., Fraser, B.J. & Rickards, T. (1997, March). *Gender and cultural differences in teacher-student interpersonal behavior.* Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

Fisher, D.L., Henderson, D. & Fraser, B.J. (1995). Interpersonal behaviour in senior high school biology classes. *Research in Science Education*, 25, 125–133.

Fisher, D., Henderson, D. & Fraser, B. (1997). Laboratory environments and student outcomes in senior high school biology. *American Biology Teacher*, 59, 214–219.

Fisher, D.L. & Waldrip, B.G. (1997). Assessing culturally sensitive factors in the learning environment of science classrooms. *Research in Science Education*, 27, 41–49.

Fraser, B.J. (1979). Evaluation of a science-based curriculum. In H.J. Walberg (Ed.), *Educational environments and effects: evaluation, policy, and productivity* (pp. 218–234). Berkeley, CA: McCutchan.

Fraser, B.J. (1986). *Classroom environment*. London: Croom Helm.

Fraser, B.J. (1990). *Individualised Classroom Environment Questionnaire*. Melbourne, Australia: Australian Council for Educational Research.

Fraser, B.J. (1993). Incorporating classroom and school environment ideas into teacher education programs. In T.A. Simpson (Ed.), *Teacher educators' annual handbook* (pp. 135–152). Brisbane, Australia: Queensland University of Technology.

Fraser, B.J. (1994). Research on classroom and school climate. In D. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 493–541). New York: Macmillan.

Fraser, B.J. (1996, May). *'Grain sizes' in educational research: combining qualitative and quantitative methods*. Paper presented at the Conference on Improving Interpretive Research Methods in Research on Science Classroom Environments, Taipei, Taiwan.

Fraser, B.J. (1997). NARST's expansion, internationalization and cross-nationalization (1996 Annual Meeting Presidential Address). *NARST News*, 40(1), 3–4.

Fraser, B.J. (1998). Science learning environments: Assessment, effects and determinants. In B.J. Fraser & K.G. Tobin (Eds.), *International handbook of science education* (pp. 527–564). Dordrecht, The Netherlands: Kluwer.

Fraser, B.J., Anderson, G.J. & Walberg, H.J. (1982). *Assessment of learning environments: manual for Learning Environment Inventory (LEI) and My Class Inventory (MCI)* (3rd vers.). Perth, Australia: Western Australian Institute of Technology.

Fraser, B.J. & Deer, C.E. (1983). Improving classrooms through use of information about learning environment. *Curriculum Perspectives*, 3(2), 41–46.

Fraser, B.J. & Fisher, D.L. (1983a). Student achievement as a function of person-environment fit: a regression surface analysis, *British Journal of Educational Psychology*, 53, 89–99.

Fraser, B.J. & Fisher, D.L. (1983b). Use of actual and preferred classroom environment scales in person-environment fit research. *Journal of Educational Psychology*, 75, 303–313.

Fraser, B.J., Fisher, D.L. & McRobbie, C.J. (1996, April). *Development, validation, and use of personal and class forms of a new classroom environment instrument*. Paper presented at the annual meeting of the American Educational Research Association, New York.

Fraser, B.J., Giddings, G.J. & McRobbie, C.J. (1995). Evolution and validation of a personal form of an instrument for assessing science laboratory classroom environments. *Journal of Research in Science Teaching*, 32, 399–422.

Fraser, B.J. & McRobbie, C.J. (1995). Science laboratory classroom environments at schools and universities: a cross-national study. *Educational Research and Evaluation*, 1, 289–317.

Fraser, B.J. & O'Brien, P. (1985). Student and teacher perceptions of the environment of elementary-school classrooms. *Elementary School Journal*, 85, 567–580.

Fraser, B.J. & Tobin, K. (1989). Student perceptions of psychosocial environments in classrooms of exemplary science teachers. *International Journal of Science Education*, 11, 14–34.

Fraser, B.J. & Tobin, K. (1991). Combining qualitative and quantitative methods in classroom environment research. In B.J. Fraser & H.J. Walberg (Eds.), *Educational environments: evaluation, antecedents and consequences* (pp. 271–292). London: Pergamon.

Fraser, B.J. & Treagust, D.F. (1986). Validity and use of an instrument for assessing classroom psychosocial environment in higher education. *Higher Education*, 15, 37–57.

Fraser, B.J., Treagust, D.F. & Dennis, N.C. (1986). Development of an instrument for assessing classroom psychosocial environment at universities and colleges. *Studies in Higher Education*, 11, 43–54.

Fraser, B.J. & Walberg, H.J. (Eds.). (1991). *Educational environments: evaluation, antecedents and consequences*. London: Pergamon.

Fraser, B.J., Walberg, H.J., Welch, W.W. & Hattie, J.A. (1987). Syntheses of educational productivity research. *International Journal of Educational Research*, 11(2), 145–252 (whole issue).

Goh, S.C. & Fraser, B.J. (1996). Validation of an elementary school version of the Questionnaire on Teacher Interaction. *Psychological Reports*, 79, 512–522.

Goh, S.C., Young, D.J. & Fraser, B.J. (1995). Psychosocial climate and student outcomes in elementary mathematics classrooms: a multilevel analysis. *Journal of Experimental Education*, 64, 29–40.

Goldstein, H. (1987). *Multilevel models in educational and social research*. London: Charles Griffin.

Haertel, G.D., Walberg, H.J. & Haertel, E.H. (1981). Socio-psychological environments and learning: a quantitative synthesis. *British Educational Research Journal*, 7, 27–36.

Hofstein, A. & Lazarowitz, R. (1986). A comparison of the actual and preferred classroom learning environment in biology and chemistry as perceived by high school students. *Journal of Research in Science Teaching*, 23, 189–199.

Huang, T.-C.I., Fraser, B.J. & Aldridge, J.M. (1998, March). *Combining quantitative and qualitative approaches in studying classroom climate in Taiwan and Australia*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Diego, CA.

Jegede, O.J., Fraser, B.J. & Fisher, D.L. (1995). The development and validation of a distance and open learning environment scale. *Educational Technology Research and Development*, 43, 90–93.

Jegede, O.J., Fraser, B.J. & Okebukola, P.A. (1994). Altering socio-cultural beliefs hindering the learning of science. *Instructional Science*, 22, 137–152.

Khoo, H.S. & Fraser, B.J. (1997, March). *The learning environments associated with computer application courses for adults in Singapor*e. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

Maor, D. & Fraser, B.J. (1996). Use of classroom environment perceptions in evaluating inquiry-based computer assisted learning. *International Journal of Science Education*, 18, 401–421.

Marjoribanks, K. (1991). Families, schools, and students' educational outcomes. In B.J. Fraser & H.J. Walberg (Eds.), *Educational environments: evaluation, antecedents and consequences* (pp. 75–91). London: Pergamon.

McRobbie, C.J. & Fraser, B.J. (1993). Associations between student outcomes and psychosocial science environment. *Journal of Educational Research*, 87, 78–85.

Midgley, C., Eccles, J.S. & Feldlaufer, H. (1991). Classroom environment and the transition to junior high school. In B.J. Fraser & H.J. Walberg (Eds.), *Educational environments: evaluation, antecedents and consequences* (pp. 113–139). London: Pergamon.

Moos, R.H. (1974). *The Social Climate Scales: an overview*. Palo Alto, CA: Consulting Psychologists Press.

Moos, R.H. (1979). Evaluating educational environments: procedures, measures, findings and policy implications. San Francisco, CA: Jossey-Bass.

Moos, R.H. (1991). Connections between school, work, and family settings. In B.J. Fraser & H.J. Walberg (Eds.), *Educational environments: evaluation, antecedents and consequences* (pp. 29–53). London: Pergamon.

Moos, R.H. & Trickett, E.J. (1987). *Classroom Environment Scale manual* (2nd ed.). Palo Alto, CA: Consulting Psychologists Press.

Riah, H., Fraser, B.J. & Rickards, T. (1997, June). *Interpersonal teacher behaviour in chemistry classes in Brunei Darussalem's secondary schools*. Paper presented at the International Seminar on Innovations in Science and Mathematics Curricula, Bandar Seri Begawan, Brunei Darussalam.

Stern, G.G., Stein, M.I. & Bloom, B.S. (1956). *Methods in personality assessment*. Glencoe, IL: Free Press.

Taylor, P.C., Dawson, V. & Fraser, B.J. (1995, April). *Classroom learning environments under transformation: a constructivist perspective*. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Taylor, P.C., Fraser, B.J. & Fisher, D.L. (1997). Monitoring constructivist classroom learning environments. *International Journal of Educational Research*, 27, 293–302.

Teh, G. & Fraser, B.J. (1994). An evaluation of computer-assisted learning in terms of achievement, attitudes and classroom environment. *Evaluation and Research in Education*, 8, 147–161.

Teh, G. & Fraser, B.J. (1995a). Associations between student outcomes and geography classroom nvironment. *International Research in Geographical and Environmental Education*, 4(1), 3–18.

Teh, G. & Fraser, B. (1995b). Development and validation of an instrument for assessing the psychosocial environment of computer-assisted learning classrooms. *Journal of Educational Computing Research*, 12, 177–193.

Thorp, H., Burden, R.L. & Fraser, B.J. (1994). Assessing and improving classroom environment. *School Science Review*, 75, 107–113.

Tobin, K. & Fraser, B.J. (1998). Qualitative and quantitative landscapes of classroom learning environments. In B.J. Fraser & K G. Tobin (Eds.), *International handbook of science education* (pp. 623–640). Dordrecht, The Netherlands: Kluwer.

Tobin, K., Kahle, J.B. & Fraser, B.J. (Eds.). (1990). *Windows into science classes: problems associated with higher-level cognitive learning*. London: Falmer Press.

Walberg, H.J. (1981). A psychological theory of educational productivity. In F. Farley & N.J. Gordon (Eds.), *Psychology and education: the state of the union* (pp. 81–108). Berkeley, CA: McCutchan.

Walberg, H.J. (1986). Synthesis of research on teaching. In M.C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed.; pp. 214–229). Washington, DC: American Educational Research Association.

Walberg, H.J. & Anderson, G.J. (1968). Classroom climate and individual learning. *Journal of Educational Psychology*, 59, 414–419.

Walberg, H.J., Fraser, B.J. & Welch, W.W. (1986). A test of a model of educational productivity among senior high school students. *Journal of Educational Research*, 79, 133–139.

Wong, A.F.L. & Fraser, B.J. (1995). Cross-validation in Singapore of the Science Laboratory Environment Inventory. *Psychological Reports*, 76, 907–911.

Wong, A.L.F. & Fraser, B.J. (1996). Environment-attitude associations in the chemistry laboratory classroom. *Research in Science and Technological Education*, 14, 91–102.

Wong, A.F.L., Young, D.J. & Fraser, B.J. (1997). A multilevel analysis of learning environments and student attitudes. *Educational Psychology*, 17, 449–468.

Woods, J. & Fraser, B.J. (1995, April). *Utilizing feedback data on students' perceptions of teaching style and preferred learning style to enhance teaching effectiveness*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Francisco, CA.

Woods, J. & Fraser, B.J. (1996, April). *Enhancing reflection by monitoring students' perceptions of teaching style and preferred learning style*. Paper presented at the annual meeting of the American Educational Research Association, New York.

Wubbels, Th. & Brekelmans, M. (1998). The teacher factor in the social climate of the classroom. In B.J. Fraser & K.G. Tobin (Eds.), *International handbook of science education* (pp. 565–580). Dordrecht, The Netherlands: Kluwer.

Wubbels, Th., Brekelmans, M. & Hooymayers, H. (1991). Interpersonal teacher behavior in the classroom. In B.J. Fraser & H.J. Walberg (Eds.), *Educational environments: evaluation, antecedents and consequences* (pp. 141–160). London: Pergamon.

Wubbels, Th. & Levy, J. (Eds.). (1993). *Do you know what you look like: interpersonal relationships in education*. London: Falmer Press.

Yarrow, A. & Millwater, J. (1995). SMILE: Student Modification In Learning Environments – establishing congruence between actual and preferred classroom learning environment. *Journal of Classroom Interaction*, 30(1), 11–15.

Yarrow, A., Millwater, J. & Fraser, B. (1997, March). *Improving university and elementary school classroom environments through preservice teachers' action research*. Paper presented at the annual meeting of the American Educational Research Association, New York.

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