CHAPTER 2

REVIEW OF RELATED LITERATURE

2.0 Introduction

The focus of research on the teaching-learning process has been shifting gradually in the last few decades from the study of the impact of traditional variables like intelligence and achievement to other important variables, including classroom learning environment (Goh, Young & Fraser,1996). The classroom environment was conceptualised by Anderson and Walberg (as cited in Hofstein, Gluzman, Ben-Zvi & Samuel 1980) as one of the four components of learning process, namely, learning, instruction, aptitude (ability), and environment. According to Lawrenz (1987), Getzels and Thelen have presented a framework for the analysis of a school classroom as a unique social system, suggesting that classroom climate is one of the variables which can interact with, as well as predict, the achievement and attitude of students. Bloom (1964) also emphasised the importance of the environment in which students learnt. He proposed that measures of classroom environment be used for the prediction of student achievement as well as for the evaluation of student abilities.

Myers and Fouts (1992) defined classroom environment as the unique interactive combination of teacher behaviours, curriculum expectations, and the student-to-student interactions which develop in the classroom setting. The measure of classroom environment is the individual student's perception of these interactions. According to Walberg (1976), students may be best able to determine what affects their intentions and their ability to learn. Similarly, Fraser (1989) reiterates that 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.

Fraser and Walberg (1981) outlined the advantages in the use of student perceptual measures in preference to classroom interaction techniques that involve observation. These are :

(1) Paper-and-pencil perceptual measures are more economical than classroom interaction techniques which involve the expense of trained observers and large amounts of coding by hand.

(2) Perceptual measures are based on students' experiences over many lessons, while interaction data are usually restricted to a very small number of lessons.

(3) Perceptual measures involve the pooled judgments of all the students in a class, whereas interaction techniques typically involve only a single observer.

(4) Students' perceptions, because they are the determinants of student behaviour more so than the 'real' situation, can be important than observed behaviours.

(5) Perceptual measures of classroom environment have typically been found to account for considerably more variance in student learning outcomes than have directly observed variables.

Thus, perceptual measures, as compared to interaction techniques that involve observations, have the advantage of characterising the class through the eyes of the actual participants and capturing data which the observer could miss or consider unimportant (Fraser, 1989).

Measurement and investigation of the perceptions of the psychosocial characteristics of the learning environment at the elementary, secondary, and higher education levels have gained a considerable amount of attention from researchers (Asghar, 1996; Asghar & Fraser, 1996; Bowen, 1994; Chavez, 1984; Fraser, Giddings & McRobbie, 1995; Fraser et al., 1993; Goh et al., 1996; Maor & Fraser,1996; McRobbie & Fraser, 1993).

Classroom environment instruments have been used as sources of both predictor and criterion variables in numerous studies. For example, in the study by Fraser and Fisher (1982) involving 116 Australian junior high school science classes, the researchers reported relationships between students' learning outcomes and their perceptions of the classroom environment measured by two instruments, namely, the Classroom Environment Scale (CES) and the Individualized Classroom Environment Questionnaire (ICEQ).

The results showed that the multiple correlations between the learning outcomes (inquiry skills and science-related attitudes) and the classroom environment dimensions for raw scores ranged from .44 to .61, using the class as the unit of analysis. The findings of their study showed consistent support for the existence of overall relationships between learning outcomes and classroom environment

Other studies involving the use of classroom environment scales as the criterion variables have revealed that classroom psychosocial climate varies between alternative curricula (Levine, Schmidt, & Zellermayer, 1996; Maor & Fraser, 1996). The results from the study by Levine et al. (1996) showed that of the six dimensions of the class climate examined, two of the dimensions indicated a more positive perception of the classroom climate among the experimental group of 659 students who were exposed to communicative instructional approach to writing within a technological environment as compared to those taught by the traditional method.

In this study, the researcher will employ the SLEI to investigate the associations between students' perception of the science laboratory environment and their science achievement and attitude toward science. Gender differences in the students' perception of the science laboratory environment will also be studied.

The following Sections 2.1 to 2.4 describe the review of literature related to the present study.

2.1 Instruments for Assessing Classroom Environment

Table 2.1 provides an overview of the scales in the following instruments for assessing perceptions of the classroom learning environment :

(a) Learning Environment Inventory (LEI);
(b) Classroom Environment Scale (CES);
(c) Individualised Classroom Environment Questionnaire (ICEQ);
(d) My Class Inventory (MCI);
(e) College and University Classroom Environment Inventory (CUCEI); and
(f) Science Laboratory Environment Inventory (SLEI).

For each of the instruments , Fraser (1989) summarised the levels for which the instruments are most suited. In addition, Table 2.1 also shows

Table 2.1

Overview of Scales in Six Classroom Environment Instruments

Instrument	Level	Items per Scale	Scales Classified According to Moo's Scheme: Relationship Dimensions	Personal Development Dimensions	System Maintenance and System Change Dimensions
LEI	Secondary	7	Cohesiveness Friction Favouritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material Environment Goal Direction Disorganization Democracy
CES	Secondary	10	Involvement Affiliation Teacher Support	Task Orientation Competition	Order and Organization Rule clarity Teacher Control Innovation
ICEQ	Secondary	10	Personalisation Participation	Independence Investigation	Differentiation
MCI	Primary, Lower Secondary	6-9	Cohesiveness Friction Satisfaction	Difficulty Competitiveness	
CUCEI	Higher Education	7	Personalisation Involvement Student Cohesiveness Satisfaction	Task Orientation	Innovation Individualism
SLEI	Secondary, Higher Education	5	Student Cohesiveness	Open-endedness Integration	Rule Clarity Material Environment

Source: Fraser (1989)

the number of items contained in each scale. It should be noted that the scales of each instrument are classified according to Moo's (1974) three basic dimensions :

1. 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 each other;

2. Personal Development Dimensions — which assess basic directions along which personal growth and self-enhancement tend to occur; and

3. 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.

2.1.1 The Learning Environment Inventory (LEI)

The most widely used perceptual measure of psychosocial environment in science education has been the LEI, developed by Anderson and Walberg for their evaluation of Harvard Project Physics (Walberg, 1969). The LEI measures 15 climate dimensions with a total of 105 statements (seven items per scale) descriptive of typical school classes. The respondent expresses the degree of agreement or disagreement with each statement on a 4-point scale with response alternatives of Strongly Disagree, Disagree, Agree and Strongly Agree (Fraser, 1989).

Cronbach alpha reliabilities in the range of .53 to .85 based on Anderson's study, were cited by Hofstein et al. (1980).

2.1.2 The Classroom Environment Scale (CES)

The CES was developed by Rudolf Moos at the Stanley University over two decades ago (Fraser, 1989). This instrument was the first social climate scale developed for use in psychiatric hospitals and other human environments (Maor & Fraser, 1996).

The CES contains nine scales with 10 items of True-False format in each scale. The CES scales displayed adequate internal consistency reliability with the alpha coefficients ranging from .60 to .90 (Fraser & Fisher, 1982).

2.1.3 The Individualised Classroom Environment Questionnaire (ICEQ)

The ICEQ was developed by Rentoul and Fraser (1979) to measure those dimensions which differentiate individualised classroom, including open and inquiry-based classrooms, from the conventional ones (Fraser

& Walberg, 1981).

The ICEQ contains 50 items altogether, with an equal number of items belonging to each of the five scales. Each item is responded to, on a 5-point scale with the alternatives of Almost Never, Seldom, Sometimes, Often, and Very Often.

Internal consistency estimates of alpha coefficients were found to range from .74 to .92 for the actual forms of the ICEQ scales (Fraser & Fisher, 1982).

2.1.4 My Class Inventory (MCI)

The LEI has been simplified to form the MCI, which is suitable for children between 8 to 12 years of age (Fisher & Fraser, 1981). Fraser (1989) reported that the MCI differs from the LEI in four important ways:

(1) to minimise fatigue, the MCI contains only five of the LEI's original 15 scales;

(2) item wording has been simplified to enhance readability;

(3) the LEI's 4-point response format has been simplified to a 2-point (Yes-No) response format; and

(4) to avoid errors in transferring responses to separate response sheets, the students answer on the questionnaire itself.

The MCI contains 38 items with Cronbach alpha reliabilities for each scale ranging from .73 to .88 (Lawrenz, 1987).

2.1.5 College and University Classroom Environment Inventory (CUCEI)

The CUCEI was developed to measure the higher education classroom environment in colleges and universities (Fraser et al.,1986). This instrument is intended for small classes (up to 30 students) and it is not suited to lectures or laboratory classes. The final form of the CUCEI contains seven scales, each containing seven items with the four responses of Strongly Agree, Agree, Disagree, and Strongly Disagree.

Fraser (1989) reported that the Cronbach alpha reliabilities range from .70 to .90 for the CUCEI scales.

2.1.6 The Science Laboratory Environment Inventory (SLEI)

Due to the critical importance and uniqueness of laboratory settings in science education, the SLEI was developed by Fraser et al. (1993) to assess the students' perception of the psychosocial environment of the science laboratory. The SLEI has five 7-item scales with the response alternatives of Almost Never, Seldom, Sometimes, Often and Very Often.

From the cross-national validation of the SLEI by Fraser et al. (1993), it was reported that the internal consistency of the actual form of each of the scales as measured by Cronbach alpha coefficients range from .70 to .83, using individual student mean as the unit of analysis, and .81 to .95 using class mean as the unit of analysis.

The initial preliminary version of the SLEI containing altogether 72 items in eight scales was cross-nationally field tested, refined and validated (Fraser et al., 1993) with a sample of 3,727 students in 198 science laboratory classes from six countries (Australia, the United States, Canada, England, Israel, and Nigeria). The alpha reliability that ranges from .70 to .95 for each of the scales of the actual and preferred forms of the refined version of the SLEI as reported by the researchers suggest that each of the SLEI scales has acceptable internal consistency.

Further analysis by the researchers indicated that the SEI has adequate discriminant validity with mean correlation with other scales ranging from .07 to .45. The data suggest that the SLEI measures distinct, although somewhat overlapping, aspects of classroom environment. Another characteristic of the actual form of the SLEI is that each scale has the ability to differentiate significantly ($p < .001$) between the perceptions of students in different classrooms.

In addition, the researchers were able to demonstrate the predictive validity of the SLEI by investigating the associations between the students' attitude to science laboratory work and their perception on the SLEI.

The findings showed that the dimensions of the SLEI were positively related with students' attitude. Furthermore, it also showed that more favourable student attitude toward laboratory work was found in classes perceived to be higher in Student Cohesiveness and Integration.

To further establish the validity of the instrument, the researchers (McRobbie & Fraser, 1993) cross-validated the SLEI with a new sample of 1594 chemistry students in 92 classes in 52 schools. Analyses of the data further support the internal consistency reliability, discriminant validity, factorial validity, and predictive validity of the actual and preferred forms of the SLEI.

In the local scene, the SLEI was adapted to measure the students' perception of their physics laboratory by Chan (1995). Findings showed that the scales of the adapted SLEI have Cronbach reliability coefficients ranging from .42 to .79. Results from the one-way ANOVA, using the scales as dependent variables and the classes in the study as independent variables, indicated that there was a significant difference ($p < .05$) in the perception of Student Cohesiveness among the different classes.

For the present study, the SLEI would be the most appropriate instrument that can be used for measuring the students' perception of the science laboratory psychosocial environment.

2.2 Relationship between Students' Perception of Classroom Environment and Cognitive Learning Outcomes.

"Many studies have provided consistent and strong support for the predictive validity of students' perception of the classroom learning environment in accounting for appreciable amounts of learning outcome variance" (Fraser & Fisher, 1982, p. 499).

The practical implication of this kind of research is that feedback from the students' perception of their classroom environment can be utilised to improve the learning environment so that it becomes conducive for optimum learning.

Findings from the study by Walberg (1969) involving 3,700 students from 144 classes, showed that learning environment measured by the LEI significantly predicted the cognitive learning outcomes measured by the tests on Science Understanding, Science Processes and Physics Achievement. Multiple correlations ranging from .59 to .63 ($p <$ .001) between the LEI scales as predictors and the cognitive posttests of Understanding Science, Science Processes and Physics Achievement (as the criteria), were obtained in the study. It was noted that simple correlation analysis of each LEI scales and the criteria showed that Difficulty was the best predictor of the cognitive tests with simple correlations ranging from .40 to .43 ($p <$ .001).

In the study by Goh et al. (1996), multiple linear regression analysis involving the modified version of the MCI scales, showed that Friction was a significant independent predictor at $p < .01$ for mathematics achievement. Standardised regression coefficients of $-.27$ (student score as the unit of analysis) and $-.90$ (class mean as the unit of analysis) for the dimension of Friction when the other three climate scales of Cohesion, Competition, and Task Orientation were controlled, accounted significant ($p < .01$) variance in the student achievement. In addition, Cohesion, with standardised regression coefficient of .06, was a significant ($p < .05$) independent predictor of mathematics achievement. The study suggested that a lesser amount of friction in the class that was cohesive is related to higher achievement in mathematics.

In another study by McRobbie and Fraser (1993), the SLEI was used to investigate 1,594 senior high school chemistry students' perceptions of the psychosocial environment of their science laboratory classes. Simple, multiple, and canonical correlation analyses between cognitive outcomes and the SLEI scales were performed. The cognitive outcomes were measured by two inquiry skill scales in chemistry named Conclusions and Generalizations, and the Design of Experimental Procedures that were adapted from Fraser's (1979) Test of Enquiry Skills and an item bank (Australian Council for Educational Research, 1978).

Simple correlation analysis showed that each of the environment scales were positively correlated ($p < .05$) with the learning outcomes except for Open-endedness. It was noted that higher perceived Open-endedness was associated with lower scores on the Conclusions and Generalizations.

Multiple correlations for both the inquiry scales were .23 and .30 with the individual as the unit of analysis and .42 and .44 with the class mean as the unit of analysis. These values of multiple correlations between the cognitive outcome scores and the set of environment scales were significant at $p < .05$.

The results of regression analysis in which the general ability and the four other environment scales were controlled, indicated that Integration was positively related with cognitive outcomes, with β weights ranging .18 to .49 ($p < .01$). However, Rule Clarity was negatively related to both the inquiry skill outcomes with β weights ranging from -.09 to -.41.

2.3 Relationship between Students' Perception of Classroom Environment and Attitude toward Science.

The study by Fraser and Butts (1982) involving 712 junior high school science students investigated the relationship between students' perception of classroom environment, measured by the ICEQ scales as the predictor variables and the seven distinct attitudes as the criterion variables, measured by the Test of Science-Related Attitudes (TOSRA). The TOSRA contains 70 items of 5-point Likert format measuring the seven scales: Social Implications of Science, Normality of Scientists, Attitude towards Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science and Career Interest in Science. Each scale has a total of ten items. Hierarchical regression analysis results of the effects of pretest attitude and five ICEQ scales on each of the attitude posttest criterion showed that the total R^2 values for each of the attitude scales ranged from .42 to .62 and were significant at $p < .01$. Findings showed that Enjoyment of Science Lessons scores were greater in classrooms perceived as having greater Personalisation, Independence and Participation.

In the study of Haladyna et al. (1982) , the Inventory of Affective Aspects of Schooling (IAAS) was developed to measure attitude toward science, the learning environment, and student and teacher variables. The purpose of the study was to identify the possible determinants of attitudes toward the subject matter in science. Attitude scales for this instrument were adapted from a self-report attitude inventory by Haladyna and Thomas, (1979) while the learning environment items were adapted from the LEI and MCI. This study involved students in grades four, seven and nine who were identified through a stratified random sampling plan to ensure that school in urban and rural conditions were included in the study. Correlation analyses between the predictor variable of the learning environment and the criterion variable of attitude toward science were conducted. Findings from the seventh and ninth grades indicated that Class Environment, Attentiveness, and Satisfaction of the IAAS showed significant correlations with the criterion variable of attitude toward science for both the levels. Product-moment correlations between each of the scales in the learning environment as the predictor variables and the criterion variable of attitude toward science ranged from .18 to .48 ($p < .01$) for separate analysis for boys and girls of the seventh and ninth grades.

In a study that examined the relationship between the 15 scale scores of the LEI and seven scale scores of the TOSRA for 40 science classes in Taiwan (Lin and Crawley, 1987), correlation analysis results indicated that Speed and Competitiveness scales of the LEI were directly associated with three science-related attitudes, namely, Social Implication of Science, Attitude to Scientific Inquiry, and Adoption of Scientific Attitudes. The correlation values ranged from .59 to .68 and were significant at $p < .001$.

In the study by Lawrenz (1976), stepwise multiple-regression analysis was employed to obtain information on how well the dependent variables of biology, chemistry, and physics students' attitude toward science can be predicted from the ten scales of the LEI as the independent variables. Science Attitude Inventory (SAI), with 60 Likert-type items and test-retest reliability of .93, was used to measure the dependent variable of attitude toward science for biology, chemistry or physics classes. Findings from the study indicated that Favouritism scale of the LEI was the best predictor of biology students' attitude toward science, which was significant at $p < .05$. In addition, the results showed that Friction was a significant ($p < .05$) predictor for chemistry students' attitude toward science. The results of the study, based on the predictor criteria of the LEI scales, showed that 23% and 27% of the variance of the students' attitudes toward science of the biology and chemistry classes respectively, was accounted for by students' perception of the learning environment. However, findings showed that the predictor variables of the LEI scales were not significant predictors of the students' attitude toward science for the physics classes. The lack of any significant relationship for the physics students was explained by the self-selection process operating in the physics enrolment.

2.4 Gender Differences in Perception of Classroom Environment.

Numerous studies have also investigated the gender differences in students' perception of the classroom environment (Asghar, 1996;

Fraser et al., 1995; Lawrenz, 1987) . Findings from such studies may guide in the practical attempts, if necessary, to improve classroom environment that will benefit both the boys and girls. Findings of the study by Lawrenz (1987) indicated that there were gender related differences in student's perception of the classroom psychosocial environment and these differences become more pronounced with increasing grade level. The study involved 149 fourth graders from 13 different schools, 184 seventh graders from 21 schools and 58 high school students from six schools. MANOVA results showed that for high school students, there was significant ($p < .01$) gender difference on the Cohesiveness scale of the LEI. The girls viewed their classes more cohesive than the boys.

Gender differences in the perceptions of the science laboratory classrooms were also shown in the study of Fraser et al. (1995), involving 258 students in 29 classes. A series of *t* tests confirmed that there were significant ($p < .05$) gender differences for Student Cohesiveness and Integration of the SLEI. It was found that girls generally perceived the science laboratory classroom environment as more cohesive and integrated than did the males.

However, findings from the study involving 120 Form Three students in Brunei (Asghar, 1996) indicated no significant gender differences in students' perception of their science classroom environment. The pupils' perception of science classroom environment was measured by the ICEQ.

The data were analysed using *t*-test to determine whether there were significant gender differences in the pupils' perception of the science classroom environment. The findings showed that the *t*-values for all the ICEQ indicated no significant gender differences for all the scales.

The study of Lin and Crawley (1987) comprising 1,269 eighth grade students from 40 classes in Taiwan, reported similar findings as those reported in the study by Asghar (1996). In this study, *t*-test was used to examine the differences in the LEI scales among students of different gender. None of the *t*-values of the LEI scales were significant for gender difference.