# A Longitudinal Study of the Psychosocial Environmental and Learning Approaches in the Hong Kong Classroom

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ABSTRACT **Structural equation models linking cognitive and affective factors, approach to learning, and perceptions of the actual and preferred mathematics classroom environments were tested in a longitudinal study involving 356 secondary school students in Hong Kong. Models of acceptable fit that clarified the effects of classroom environment on how students learn and the outcomes they achieve were obtained. Numerous significant paths from prior learning experience to environmental variables were identified; the most salient path from classroom environment to learning outcomes was that between an enjoyable classroom environment and cognitive achievement. An enjoyable classroom environment mediated the causal relationship between a deep approach and high-level achievement. However, classroom environment did not seem to influence changes in approach to learning.**

Various models that include many cognitive, affective, and social factors have been suggested by educational psychologists to portray the complex process of school learning. One of the best elaborated and most widely tested of the models, Walberg's (1981, 1983, 1984, 1986) educational productivity model, links the nine variables of ability, development, motivation, amount and quality of instruction, home, classroom, peers, and out-of-academic learning environments. As distinct from most other school learning models, the learning environment in Walberg's productivity model is of major importance. However, how this environment influences the way a student studies and the cognitive and affective outcomes he or she achieves are questions yet to be answered.

Among the four classes of environmental variables (home, school, peer, and the mass media) considered in a meta-analysis based on Walberg's productivity model, home environment and classroom environment had the largest average correlations with achievement (Fraser, Walberg, Welch, & Hattie, 1987; Walberg, 1984). Another meta-analysis revealed that the environmental variables that affected student outcomes most were cohesiveness, satisfaction, task difficulty, and goal direction (Haertel, Walberg, & Haertel, 1981). With the help of a three-wave panel design, Reynolds and Walberg (1992) tested and validated a structural model, based on Walberg's productivity model, that connected mathematics achievement, attitude, and seven affective/social variables—motivation; instructional time; perceived instructional quality; and mass media, home, peer, and classroom environments.

The classroom environment variable, however, was dropped from that study because "a satisfactory measure of classroom environment was not available" (Reynolds & Walberg, 1992, p. 314). Not only is there a close relationship between the actual classroom environment and academic achievement (Fraser, 1986, 1991, 1994), research has also shown that those students who prefer a certain type of classroom environment are more likely to choose a particular approach to learning (Chan & Watkins, 1994; Hattie & Watkins, 1988; Ramsden, Martin, & Bowden, 1989). Research on the quality of student learning has indicated that approaches to learning have direct effects on learning outcomes (Biggs, 1979; Entwistle & Ramsden, 1986; Schmeck, 1988).

The process of learning was conceptualized by Biggs's 3P model of learning (Biggs, 1978, 1987; Biggs & Telfer, 1987), in which student learning was categorized in terms of input (*p*resage), approach (*p*rocess), and output (*p*roduct) stages. In the process stage, students use strategies consistent with their motives in the process stage; this association of motive and strategy is called the *approach to learning*. Three approaches to learning—surface, deep, and achieving—have been identified with both quantitative and qualitative methods (Biggs, 1979, 1987; Entwistle & Ramsden, 1983; Marton & Säljö, 1976; Watkins, 1983). These different approaches to learning, it is argued, determine the quality of learning outcomes.

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A *surface approach* is based on extrinsic motivation or fear of failure. Those students who use a surface approach view school learning as a means toward ends such as obtaining a job, pleasing parents, or just keeping out of trouble. Minimal time and effort are invested to meet basic requirements. Rote learning of selected content, without understanding, is one of the most common strategies used in the surface approach (Biggs, 1991a, 1993).

A *deep approach*, in contrast, is based on interest in the subject matter of the task. A student who adopts a deep approach perceives the task as interesting and is personally involved in it. Thus, the strategy is to maximize understanding.

Biggs (1991a, p. 17) described the *achieving approach* as based on "the ego-enhancement that comes out of visibly achieving, and in particular through high grades." The strategy is to do whatever the student believes is likely to result in the highest marks in a particular course. This effort may involve adopting either a surface or a deep approach and typically relies on the popular study skills of cost-effective organization of time, working space, and syllabus coverage.

In this study, we attempted to extend existing models by tapping the changes in students' approaches to learning and their cognitive and affective learning factors, as influenced by the actual and preferred classroom environments in the Hong Kong mathematics classroom. The nature of the causal relationships among these factors was delineated by the use of structural equation modeling with data collected in a longitudinal panel design (see Figure 1). A number of structural equation models were tested in which the mediating roles of both the preferred and the actual classroom environments were considered.

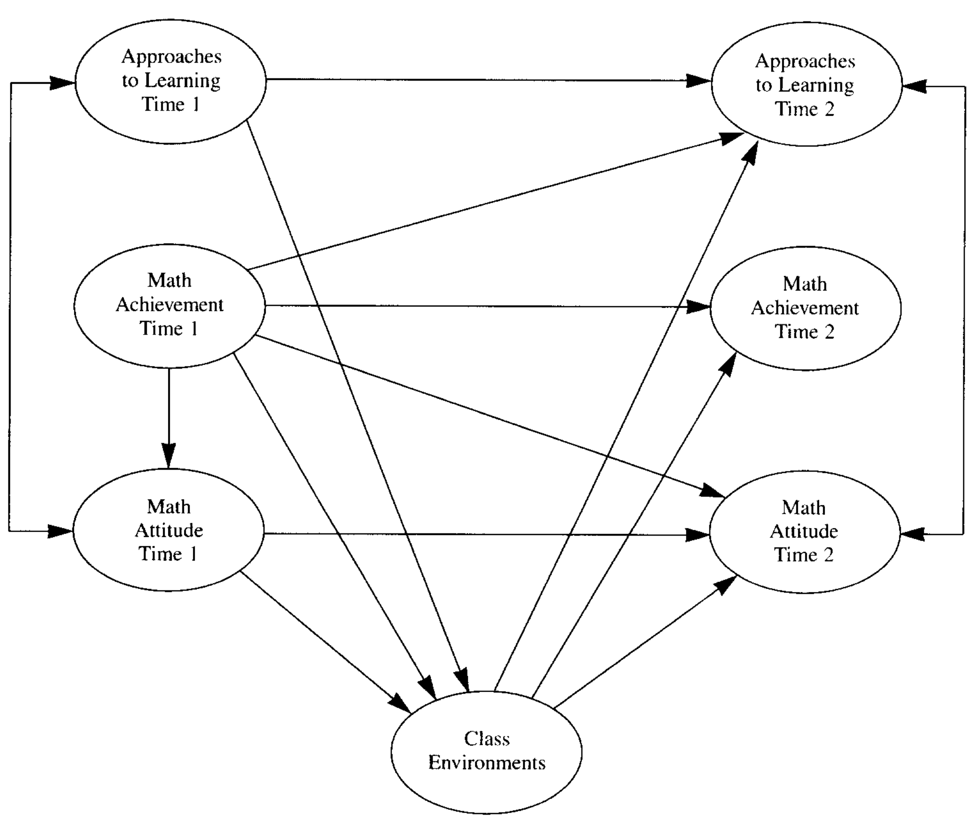
Because research has provided evidence that student achievement can be regarded as a function of person–environment fit (Fraser & Fisher, 1983a, 1983b; Rentoul & Fraser, 1980) and that a student tends to perform better academically in a learning environment closer to his or her preference, we also tested structural equation models with the difference score between the preferred and actual classroom environments. The establishment of a valid model of such relationships should provide a better understanding of the processes involved in mathematics learning and achievement.

## Method

### *Participants*

Three hundred fifty-six Grade 9 students (average age, 15 years) in nine secondary schools in Hong Kong participated in the present study. Three of the schools were rated in the top 30% academically, three of them were rated between

**Figure 1. The A Priori Structural Equation Model**



the top 30% and the bottom 30%, and the other three were rated in the bottom 30%. Among the students, 188 were girls and 168 were boys. In the middle of the academic year (January 1993), the students indicated their preferred classroom environments and their perceptions of their actual classroom environments by responding to the Mathematics Classroom Environment Scale (see the Instrument section). At both the beginning (September 1992) and end (June 1993) of the academic year, the students' measures of approach to learning and of the cognitive and affective variables were constructed.

### *Instrument*

*Classroom Environment Scale.* We sought to develop an instrument that was both culturally relevant and appropriate for actual Hong Kong mathematics classrooms. The Mathematics Classroom Environment Scale was developed through qualitative research to assess both the preferred and actual learning environments of the mathematics classroom (Wong, 1993b, 1995). This instrument comprises 54 items with a 5-point Likert-type response scale (*almost never, seldom, sometimes, often, very often*) along the five dimensions of rapport, enjoyment, involvement, teacher involvement, and achievement orientation. It was written in Chinese, the mother tongue of the participants. Sample items in each scale are given in Table 1. For each item, the students were asked to indicate how they agreed with respect to two perspectives: the preferred situation and the perceived existing situation. Thus, the two sets of Likert-type scales corresponding to the preferred and the actual environments were placed side by side to the right of the statements. The reliability indices (total coefficient of determination) found in this research ranged from .61 to .85; the goodness-of-fit indices of the whole preferred and actual scales, as evaluated by confirmatory factor analysis with the use of LISREL-8 (Jöreskog & Sörbom, 1993), were .88 and .87, respectively.

*Approach to learning.* We used Form B of the Learning Process Questionnaire (Biggs, 1992) to delineate students' approaches to learning. This form consists of six subscales; sample items in each scale are given in Table 2. We obtained a median reliability index (Cronbach's alpha) of .65, which is comparable to the reliability indices reported in Hong Kong normative research (Biggs, 1992).

*Affective and cognitive outcomes.* We used attitude toward mathematics as the affective variable and measured it with the Mathematics Semantic Differential (Minato, 1983). The scale consists of 14 bipolar statements in an 8-point response scale format. A sample item is: "School mathematics is *simple–complicated*, *beautiful–ugly*, and *boring–interesting*." The reliability indices (Cronbach's alpha) obtained at the beginning (September 1992) and end of the term (June 1993) were .92 and .93, respectively.

To assess cognitive outcomes, we used the scores on attainment tests developed by the Educational Research

**Table 1.—Subscales and Sample Items of Mathematics Classroom Environment Scale (Wong, 1993b)**

| Dimension | Sample items |
|---|---|
| Rapport | Students can find classmates to discuss mathematics with after lesson. |
| Enjoyment | Students long for the mathematics class. |
| Involvement | Students pay great effort in the mathematics class. |
| Teacher involvement | It is likely that mathematics teacher would explain the second time if s/he is requested by the students. |
| Achievement orientation | The mathematics teacher often demonstrates problems that are taken from past examination papers. |

**Table 2.—Sample Items in LPQ Form B (Biggs, 1987)**

| | Approach | |
|---|---|---|
| Item | Motive | Strategy |
| SURFACE | I want to take only those subjects in school that would help me to get a job, not those that might be more interesting. | I tend to study only what the teacher says, no more. |
| DEEP | I become interested in many school subjects when I work at them. | In reading new stuff, I am reminded of things I already know, and see them in a different way. |
| ACHIEVING | I really want to do better than anyone else in my school work. | I have my way of keeping my books, notes, and other class things so that I can find them easily. |

Establishment of the Education Department (1987a, 1987b, 1987c) and conducted each year to monitor Hong Kong students' mathematics performance in Grades 1–9. Both the Grade 8 and the Grade 9 tests comprised 42 multiple-choice questions with five options. The test areas included arithmetic, algebra, geometry, trigonometry, and statistics.

## Results

### *Correlation Coefficients*

The correlation coefficients between the cognitive variables and other major variables and those between the affective variables and other major variables are listed in Table 3.

**Table 3.—Correlation Coefficients Among Cognitive, Affective, and Other Major Variables**

| Variable | Beginning of term: Math attainment | Beginning of term: Math attitude | End of term: Math attainment | End of term: Math attitude |
|---|---|---|---|---|
| Beginning of term | | | | |
| Math attainment | 1.00 | .39* | .77* | .46* |
| Math attitude | .39* | 1.00 | .38* | .72* |
| Surface motive | –.01 | –.08 | –.01 | –.10 |
| Deep motive | .16* | .37* | .17* | .27* |
| Achieving motive | .09 | .20* | .09 | .16* |
| Surface strategy | –.17* | –.21* | –.23* | –.19* |
| Deep strategy | .13 | .31* | .08 | .23* |
| Achieving strategy | .04 | .33* | .05 | .21* |
| Preferred classroom environment | | | | |
| Rapport | .01 | .24* | .30* | .19* |
| Enjoyment | .02 | .32* | .34* | .32* |
| Involvement | .13* | .20* | .30* | .19* |
| Teacher involvement | .16* | .15* | .22* | .12 |
| Achievement orientation | .13* | .19* | .24* | .16* |
| Actual classroom environment | | | | |
| Rapport | .01 | .31* | .43* | .40* |
| Enjoyment | .07 | .49* | .49* | .56* |
| Involvement | .05 | .12 | .35* | .16* |
| Teacher involvement | .17* | .14* | .30* | .23* |
| Achievement orientation | .09 | .13 | .16* | .15* |
| End of term | | | | |
| Math attainment | .77* | .38* | 1.00 | .50* |
| Math attitude | .46* | .72* | .50* | 1.00 |
| Surface motive | –.03 | –.16* | –.09 | –.15* |
| Deep motive | .24* | .25* | .24* | .34* |
| Achieving motive | .10 | .05 | .08 | .16* |
| Surface strategy | –.15* | –.27* | –.22* | –.16* |
| Deep strategy | .19* | .16* | .13* | .27* |
| Achieving strategy | .08 | .18* | .08 | .22* |

*$p < .01$.

In general, approach to learning and classroom environment, particularly the actual environment, was highly correlated with the affective and the cognitive outcome variables. Deeper motives and strategies tended to be associated with better learning outcomes.

*Structural Equations*

We tested three structural equation models linking approach to learning and the affective and cognitive variables; classroom environment was used as a mediating variable. For the classroom environments in the three models, we used, in turn, actual environment, preferred environment, and the difference score between the two (see Figure 1).

We used LISREL-8 with the covariance matrices to test the structural equations (Jöreskog & Sörbom, 1993). The Tucker–Lewis index (TLI) and the relative noncentrality index (RNI) were used to assess the goodness of fit of the models. These two indices appear to be among the most common and useful goodness-of-fit indicators (see Bentler, 1990; Marsh & Balla, 1994; Marsh, Balla, & McDonald, 1988; McDonald & Marsh, 1990). Structural equation models with acceptable goodness-of-fit indices relating the cognitive variables, the affective variables, approach to learning, and classroom environment were obtained; the variable coefficients that were significant are shown in Tables 4–6. For the models in which actual and preferred classroom environments were used as mediating variables, the TLI and RNI obtained were .92 and .94 respectively; for the model with the difference index used as the mediating variable, the TLI and RNI were both .94.

From the structural equation model that included actual classroom environment (Table 4), we found that a deep approach led to the perception of an unenjoyable classroom, whereas an achieving approach led to a perception of teacher involvement.

A number of significant paths were found starting from prior mathematics achievement. Prior mathematics achievement was positively related to a deep approach to learning, negatively related to a surface approach to learning, and positively related to cognitive and affective learning outcomes. Furthermore, prior mathematics achievement led to an involved classroom environment. Among these paths, besides the expected strongest path between mathematics

**Table 4.—Coefficients (Standard Errors) Relating Various Variables in Causal Model Linking Actual Classroom Environment, Approaches to Learning, Cognitive Factors, and Affective Factors**

| Variable | ATT1 | RAP | ENJ | INV | TIV | AOR | SUR2 | DEE2 | ACH2 | MAT2 | ATT2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SUR1 | — | — | — | — | — | — | .636 (.084) | — | — | — | — |
| DEE1 | — | — | −.177 (.025) | — | — | — | — | .597 (.091) | — | — | — |
| ACH1 | — | — | — | — | .129 (.021) | — | — | — | .574 (.071) | — | — |
| MAT1 | .447 (.072) | — | — | .218 (.068) | — | — | −.127 (.194) | .156 (.185) | — | .820 (.178) | .152 (.057) |
| ATT1 | — | .480 (.079) | — | — | .214 (.073) | .231 (.088) | — | — | — | — | .847 (.144) |
| RAP | — | — | — | — | — | — | — | — | — | .240 (.071) | — |
| ENJ | — | — | — | — | — | — | — | — | — | — | — |
| INV | — | — | — | — | — | — | — | — | — | — | — |
| TIV | — | — | — | — | — | — | — | — | — | — | — |
| AOR | — | — | — | — | — | — | — | — | — | — | — |
| PSI | — | .770 | .555 | .952 | .920 | .947 | .580 | .620 | .678 | .143 | .144 |

*Note.* ATT1: math attitude (Time 1), ATT2: math attitude (Time 2), MAT1: math attainment (Time 1), MAT2: math attainment (Time 2), SUR1: surface approach (Time 1), SUR2: surface approach (Time 2), DEE1: deep approach (Time 1), DEE2: deep approach (Time 2), ACH1: achieving approach (Time 1), ACH2: achieving approach (Time 2), RAP: rapport, ENJ: enjoyment, INV: involvement, TIV: teacher involvement, AOR: achievement orientation, PSI: residual variance. Chi-square (156) = 288.659, RMSEA = .060 ($p$ = .065). NNFI = .917, CFI = .939.

**Table 5.—Coefficients (Standard Errors) Relating Various Variables in Causal Model Linking Preferred Classroom Environment, Approaches to Learning, Cognitive Factors, and Affective Factors**

| Variable | ATT1 | RAP | ENJ | INV | TIV | AOR | SUR2 | DEE2 | ACH2 | MAT2 | ATT2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SUR1 | — | — | — | — | — | — | .625 (.086) | — | — | — | — |
| DEE1 | — | — | — | — | — | — | — | .573 (.091) | — | — | — |
| ACH1 | — | — | — | — | — | — | — | — | .565 (.074) | — | — |
| MAT1 | .429 (.073) | — | — | .062 (.046) | — | — | −.114 (.193) | .178 (.182) | — | .892 (.216) | .170 (.092) |
| ATT1 | — | .113 (.048) | .265 (.060) | — | — | .155 (.072) | — | — | — | — | .891 (.434) |
| RAP | — | — | — | — | — | — | — | — | — | — | — |
| ENJ | — | — | — | — | — | — | — | — | — | .208 (.069) | — |
| INV | — | — | — | — | — | — | — | — | — | — | — |
| TIV | — | — | — | — | — | — | — | — | — | — | — |
| AOR | — | — | — | — | — | — | — | — | — | — | — |
| PSI | — | .987 | .930 | .996 | — | .976 | .597 | .640 | .683 | .119 | .047 |

*Note:* ATT1: math attitude (Time 1), ATT2: math attitude (Time 2), MAT1: math attainment (Time 1), MAT2: math attainment (Time 2), SUR1: surface approach (Time 1), SUR2: surface approach (Time 2), DEE1: deep approach (Time 1), DEE2: deep approach (Time 2), ACH1: achieving approach (Time 1), ACH2: achieving approach (Time 2), RAP: rapport, ENJ: enjoyment, INV: involvement, TIV: teacher involvement, AOR: achievement orientation, PSI: Residual variance. Chi-square (159) = 302.634, RMSEA = .061 ($p$ = .041). NNFI = .922, CFI = .941.

achievement taken at the beginning and end of the term, prior mathematics achievement had the most positive relationship with involvement.

The same number of significant paths were found starting from attitude toward mathematics. Again, the path between attitude toward mathematics expressed at the beginning and end of the term was strongest. We found significant paths from attitude toward mathematics to four dimensions of actual classroom environment: rapport, enjoyment, teacher involvement, and achievement orientation, among which the path between attitude and an enjoyable classroom was strongest. Thus, all of the dimensions of classroom environment were related to cognitive and affective entry characteristics. In other

**Table 6.—Coefficients (Standard Errors) Relating Various Variables in Causal Model Linking Difference Score, Approaches to Learning, Cognitive Factors, and Affective Factors**

| Variable | ATT1 | RAP | ENJ | INV | TIV | AOR | SUR2 | DEE2 | ACH2 | MAT2 | ATT2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SUR1 | — | — | — | — | — | — | .626 | — | — | — | — |
| | | | | | | | (.083) | | | | |
| DEE1 | — | — | .057 | — | — | — | — | .601 | — | — | — |
| | | | (.025) | | | | | (.093) | | | |
| ACH1 | — | — | — | — | −.077 | — | — | — | .567 | — | — |
| | | | | | (.021) | | | | (.072) | | |
| MAT1 | .448 | — | — | −.081 | — | — | −.120 | .164 | — | .926 | .180 |
| | (.071) | | | (.061) | | | (.194) | (.180) | | (.206) | (.059) |
| ATT1 | — | −.221 | −.260 | — | −.074 | −.003 | — | — | — | — | .836 |
| | | (.067) | (.077) | | (.071) | (.079) | | | | | (.152) |
| RAP | — | — | — | — | — | — | — | — | — | — | — |
| ENJ | — | — | — | — | — | — | — | — | — | −.022 | — |
| | | | | | | | | | | (.052) | |
| INV | — | — | — | — | — | — | — | — | — | — | — |
| TIV | — | — | — | — | — | — | — | — | — | — | — |
| AOR | — | — | — | — | — | — | — | — | — | — | — |
| PSI | — | .951 | .942 | .993 | .985 | .999 | .595 | .611 | .678 | .137 | .134 |

*Note:* ATT1: math attitude (Time 1), ATT2: math attitude (Time 2), MAT1: math attainment (Time 1), MAT2: math attainment (Time 2), SUR1: surface approach (Time 1), SUR2: surface approach (Time 2), DEE1: deep approach (Time 1), DEE2: deep approach (Time 2), ACH1: achieving approach (Time 1), ACH2: achieving approach (Time 2), RAP: rapport, ENJ: enjoyment, INV: involvement, TIV: teacher involvement, AOR: achievement orientation, PSI: residual variance. Chi-square (156) = 248.261, RMSEA = .050 ($p$ = .048), NNFI = .944, CFI = .939.

words, those characteristics existing before the study were essential in the creation of a classroom environment conducive to learning.

Fewer paths existed between actual classroom environment and mathematics achievement. We found that an enjoyable classroom led to better mathematics achievement.

Similar to the model for actual environment, the model concerning preferred classroom environment revealed that prior mathematics achievement was positively related to a deep approach and negatively related to a surface approach to learning (Table 5). It was also positively related to the cognitive and affective learning outcomes. Furthermore, prior mathematics achievement led to an intention to be involved in learning.

Besides the relationship between attitudes at the beginning and the end of the term, attitude toward mathematics was closely related to preferences for a harmonious (rapport), enjoyable, and achievement-oriented classroom, with the strongest tie between attitude and preference for an enjoyable classroom.

As for the model in which the difference scores between preferred and actual classroom environments were used, the paths were similar to those in the model for actual environment except that the coefficients were relatively smaller and all the signs were reversed for those paths that involved classroom environments (Table 6). Those findings were expected because the largest difference would mean the smallest congruence between preferred and actual classroom environments. Likewise, congruence in classroom environments mediated the relationship between a deep approach to learning and mathematics achievement. With the congruence of preferred and actual enjoyable classroom, a deep approach to learning led to better mathematics achievement.

## Discussion

In this study, the relationships among classroom environment, approach to learning, and cognitive and affective variables were investigated in depth through structural equation modeling; models with acceptable fit were obtained.

We found that a positive attitude toward mathematics and previous mathematics achievement not only led directly to cognitive and affective outcomes but also were closely related to students' perceptions of preferred and actual classroom environments. The relationship between attitude toward mathematics and the enjoyable dimension of classroom environment was strongest and was even comparable to the path between the two measures of the same variable (achievement and attitude) reported at the beginning and end of the term. Also interesting was the finding that prior success in mathematics influenced the students to move away from a surface approach and to opt for a deep approach to learning. The results support Meyer and Muller's (1990) suggestion that deep approaches to learning are much more strongly associated with perceptions of the learning environment than are surface approaches (see also Chan & Watkins, 1994).

In particular, a deep approach to learning led to the perception of an unenjoyable actual classroom and a preference for an achievement-oriented one, whereas an achieving approach was an antecedent to both the actual and preferred teacher-involvement dimensions. Contrary to Western research, a deep approach was associated with the notion of an unenjoyable classroom environment. This could have special connotations in the Chinese culture in which academic success is often attributed to effort and practice (Hau & Salili, 1991; Watkins & Biggs, 1996; Wong, 1993b). Hard work with sweat and tears is often believed to be an unavoidable experience needed during the course of learning. Excessive pressure exerted by highly competitive in-school and public examinations reinforces such a belief in Hong Kong classrooms (Biggs, 1991b; Ho, 1991; Morris, 1985; Wong, 1993a).

Moreover, prior success in mathematics was closely related to both the perception of and preference for an involved classroom (preferred and actual involvement). If a student perceives the classroom as enjoyable and prefers it that way, he or she will probably take a deep approach to learning, leading to better mathematics achievement.

Attitude toward mathematics was also essential in mathematics learning. A positive attitude was closely related to every dimension except the involvement dimension of both the preferred and actual classroom environments.

The above results indicate how the classroom environment influences learning outcomes. Moreover, this applied research suggests that researchers should use the following process to improve classroom environments.

1. Use an appropriate social environment instrument to collect information about the student's perceptions of the preferred and actual classroom environments.
2. Share the results with the teacher and use them to determine if a change in environment is needed.
3. In consultation with the teachers, develop strategies to bring about desired changes.
4. Readminister the instrument to monitor the success of the change (DeYoung, 1977; Fraser, 1981; Fraser & Fisher, 1986).

The model that included the difference scores between the preferred and actual classroom environments indicated that efforts to move away from an environment that influenced mathematics achievment in a negative way did support the validity of such attempts at change. If a classroom environment is created that reduces the difference to a minimum, a deep approach to learning will have a close relationship with mathematics achievement.

Finally, these structural equation models support Walberg's assertion that learning environment does have a sizable effect on learning outcomes (Walberg, 1981, 1983, 1984, 1986). There was much evidence that both the preferred and perceived classroom environments have a close relationship with learning; classroom environment should not be neglected in future models of learning. However, researchers will need to clarify the way in which the classroom environment influences how a student actually studies.

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