Californian Science Students' Perceptions of their Classroom Learning Environments

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Abstract

This study utilised the What Is Happening In this Class (WIHIC) questionnaire to examine factors that influence Californian student perceptions of their learning environment. Data were collected from 665 USA middle school science students in 11 Californian schools. Several background variables were included in the study to investigate their effects on students' perceptions, such as student and teacher gender, student ethnic background and socio-economic status (SES), and student age. Class and school variables, such as class ethnic composition, class size and school socio-economic status were also collected. A hierarchical analysis of variance was conducted to investigate separate and joint effects of these variables. Results from this study indicate that some scales of the WIHIC are more inclined to measure personal or idiosyncratic features of student perceptions of their learning environment whereas other scales contain more variance at the class level. Also, it was found that different variables affect different scale scores. A variable that consistently affected students' perceptions, regardless of the element of interest in the learning environment was student gender. Generally speaking girls perceived their learning environment more positively than did boys.

1. Rationale

Research conducted over the past 30 years has shown that the quality of the classroom environment is a significant determinant of student learning (Fraser, 1994, 1998). That is, students perform better and have more positive attitudes toward the subject taught when they perceive the classroom environment positively. Numerous studies in maths, physics, chemistry and biology education have shown that *student perceptions* of the classroom environment account for appreciable amounts of variance in learning outcomes, often beyond that attributable to background student characteristics. Moreover, students' perceptions of their teachers' behaviour do act as one set of important mediators between the actual behaviours of teachers and the actual performance of learning activities by each student (den Brok, 2001; Shuell, 1996). That is, students will only react upon those teacher behaviours that they observe and will interpret (perceive) these behaviours each in their personal idiosyncratic ways (Shuell, 1996; Stahl, 1987). Thus, in order to stimulate and optimise student learning and the environment in which they learn, knowledge of students' perceptions of this environment and the factors that influence these perceptions is crucial for both teachers and educational researchers.

According to Fraser (1998) research on students' perceptions of their classroom environment should focus on several goals: (a) establishing associations between student outcomes and perceptions of the classroom environment, (b) investigating differences between and within teacher and student perceptions, (c) investigating if students perform better in their preferred classroom environment than in other environments, and (d) studying the effects of student characteristics on classroom environments and of classroom environments on curriculum development. The present study contributes to the second aim mentioned by Fraser by connecting student, class

and teacher characteristics to student perceptions of teaching and by determining whether such variables are associated with decidedly different views of the classroom.

The investigation of learning environments has developed rapidly, with an array of validated instruments and research in several domains (e.g. evaluation of educational innovations, comparison of actual and preferred environments, and changes in classroom environment during the transition from primary to high school) (see Fraser, 1998). Typically, empirical studies have employed these instruments or contextually-modified derivatives to assess the particular environment under investigation. This study adds to this field by investigating students' perceptions of the learning environment using one particular classroom environment instrument, the *What is Happening in This Classroom (WIHIC)* questionnaire. There are several reasons for focusing on this particular instrument. First, the WIHIC combines relevant dimensions from learning environment instruments, such as investigation and relationships between teacher and students (Dorman, 2003). Because of this feature, the instrument maps a more comprehensive area of science learning environments than many of the existing learning environment instruments. At the same time, the WIHIC includes salient topics and scales from these existing instruments. Secondly, the WIHIC is one of the most widely-used instruments in the domain of learning environments research and has been validated in a number of countries. As such, the instrument has proven to be cross-culturally valid (e.g. Dorman, 2003), which is an advantage compared to some of the country-specific instruments that exist in the field. Thirdly, the instrument is capable of reliably measuring students' perceptions of important elements of their learning environment and has demonstrated predictive validity on both cognitive and affective student outcomes (e.g. Fraser, 2002). Fourth, due to the limited number of items (56 in total) and scales (7 in total), the instrument is easy to use in the classroom and only takes small amounts of time from participating students and teachers.

As mentioned earlier, it is important that both teachers and researchers have knowledge on the factors that may shape students' perceptions of their learning environment. Such knowledge may help teachers in establishing how their actions appear to their students and how learning environments may be changed in order to stimulate the learning of all students. Research in the USA (den Brok, Levy, Rodriguez, & Wubbels, 2002; den Brok, Levy, Wubbels, & Rodriguez, 2003; Levy, den Brok, Wubbels, & Brekelmans, 2003; Levy, Wubbels & Brekelmans, 1992; Wubbels & Levy, 1993) and in Australia (Aldridge, Laugksch, & Fraser, 2004; Fisher, Fraser, & Rickards, 1997; Fraser & Aldridge, 1998; Khoo & Fraser, 1997; Rawnsley & Fisher, 1997; Rickards, 1998; Rickards & Fisher, 1997; 2000; Waldrip & Fisher, 1999) has shown that several student, class and teacher characteristics are related to students' perceptions of their classroom environment. Among these associated characteristics are student and teacher gender, student and teacher ethnic background, socio-economic status, attitude and achievement, age, teacher experience and subject taught. For example, some studies have shown, that boys often have a more positive view of their science class than do girls, and that students originating from countries outside the country of interest have less favourable views of the learning environment than do native students (see also section 2.2).

While there has been a line of research investigating relationships between student, teacher and class characteristics and students' perceptions of their learning environment, this research, while making a most valuable contribution to our knowledge of what happens in classrooms, has been subject to some limitations. The methods used to estimate the effect of factors on students' perceptions have been rather imprecise and has probably *overestimated* the effect of variables. For example, such methods (regular analysis of variance, computation of correlations, etc.) have not taken into account that data were not sampled randomly. It has been shown that non-

randomly sampled data sets may lead to *artificially increased* associations between respondents and their characteristics, since respondents (in classes) share similar experiences, history and stimuli (Hox, 1995; Muthen, 1994). Using regular analysis of variance – which has been the case in many previous studies using the WIHIC - thus leads to an overestimation of possible effects (e.g. Hox, 1995). To overcome this, researchers can use multilevel analysis of variance. Multilevel analysis adjusts for the fact that data have not been sampled randomly and allows effects of multiple levels of the learning environment to exert an influence on the outcomes of any study. Moreover, in most studies, especially those interested in the WIHIC, only one (background) variable at a time was investigated in relation to perception scores, so effects have not been corrected for the presence (and effects) of other, (partially) overlapping variables. This again may have resulted in an over- or underestimation of effects or even in establishing reversed relationships (e.g. Levy, et al., 2003). In addition, no interactions between variables have been investigated.

A third feature of most studies using the WIHIC to map differences in students' perceptions is that they focussed on investigating the effects of a single student's gender and ethnic background. No WIHIC studies are known by the authors that have investigated the effects of these variables at the class and school levels (by using aggregates of these variables or by creating class-composition variables) or that have included variables such as teacher gender, class size and SES (or an aggregate of these). Research using other learning environments instruments has shown that students' perceptions may be significantly affected by these variables (e.g. Levy, et al., 2003).

Therefore, the *first objective* of this study was to validate the What Is Happening In this Class (WIHIC) questionnaire with a large sample of eighth-grade science classes in middle schools in the USA. While the WIHIC has been used in the USA before (e.g.

Hoffman Moss & Fraser, 2002; James & Fraser, 2004; MacDowell-Goggin & Fraser, 2004; Orange & Fraser, 2004; Pickett & Fraser, 2004; Soto-Rodriguez & Fraser, 2004; Taylor & Fraser, 2004), most of these studies focused on *elementary education* and on the *Eastern* part of the USA. The present study included perceptions of Californian middle school students. The *second objective* was to investigate associations between socio-economic status, student ethnic diversity and students' perceptions of their classroom learning environments at the school and student level. By employing multilevel analysis and including multiple (as well as new) background variables, the study hoped to adjust for some of the methodological limitations of previous studies investigating students' perceptions on the WIHIC.

2. Theoretical Framework

2.1 The What Is Happening In this Classroom (WIHIC) questionnaire.

Developed by Fraser, Fisher, and McRobbie (1996), the WIHIC measures high school students' perceptions of their classroom environment. The WIHIC measures a wide range of dimensions that are important to the current situation in classrooms. The WIHIC includes relevant dimensions from past questionnaires and combines these with dimensions that measure particular aspects of constructivism and other relevant factors operating in contemporary classrooms. It was designed to bring parsimony in the field of learning environments research (Dorman, 2003). A description of each scale in the WIHIC is presented in Table 1 below.

Table 1 about here

One important consideration that has been part of classroom environment theory since the early 1970s has been Moos' (1979) conceptual framework for human

environments that characterises environments as having *relationship*, *personal growth* and *system maintenance and change* dimensions. Whereas relationship dimensions are concerned with the nature and intensity of personal relationships, personal growth dimensions focus on opportunities for personal development and self-enhancement. System maintenance and system change dimensions assess the extent to which the environment is orderly, clear in expectations, maintains control and is responsive to change. Table 1 additionally shows the classification of each WIHIC scale according to Moos' scheme.

The original version of the WIHIC contained 90 items and nine scales, but was refined by both statistical analysis of data from 355 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, Fisher, & McRobbie 1996). Only 56 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, which involved high school science classes in Australia and Taiwan. The Australian sample consisted of 1,081 students in 50 classes who responded to the original English version. The Taiwanese sample of 1,879 students in 50 classes responded to a Chinese version that had undergone careful procedures of translation and back translation (Huang & Fraser 1997). This led to a final form of the WIHIC containing the seven eight-item scales.

The WIHIC has been reported as useful and valid across a number of countries and subjects (e.g. Aldridge, Laugksch, & Fraser, 2004). To date, the original questionnaire in English has been translated into Chinese for use in Taiwan (Aldridge & Fraser, 1997), Singapore (Chionh & Fraser, 1998), Korean (Kim, Fisher, & Fraser, 2000), but studies have also been conducted in countries such as Brunei (Riah & Fraser, 1998), Canada (Raaflaub & Fraser, 2002; Zandvliet & Fraser, 2002) USA (Allen & Fraser,

2002; James & Fraser, 2004; MacDowell-Goggin & Fraser, 2004; Moss & Fraser, 2001; Orange & Fraser, 2004; Soto-Rodriguez & Fraser, 2004) and Indonesia (Margianti, Fraser, & Aldridge, 2002). In some research, the questionnaire has been used without any modifications, and in others the questionnaire was adapted to suit the specific context.

Most of the studies reported above have provided information with respect to both validity and reliability of the WIHIC. Research seems to indicate that the reliability of the scales (Cronbach's Alpha) of the instrument are usually above .70 at the student level and above .85 at the class level. Exploratory and confirmatory factor analyses (e.g. Dorman, 2003) indicate that the items of the WIHIC usually have factor loadings above .40 on their *a-priori* scales and lower loadings on other scales. Moreover, the factor structure has been shown to be invariant across grade levels, countries, cultures and gender (Dorman, 2003), which suggests its usefulness in studying multicultural and heterogeneous school populations (as is the case in the present study). Average correlations between the scales of the WIHIC – a convenient measure of discriminant validity (Fraser, 1998) – have been reported between approximately .20 and .50, indicating that each of the seven scales measures distinct, though partly overlapping elements of the classroom environment.

A study by Rawnsley and Fisher (1998) investigated associations between learning environments in mathematics classrooms and students' attitudes towards that subject in Australia using the WIHIC questionnaire. It was found that students developed more positive attitudes towards their mathematics in classes where the teacher was perceived to be highly supportive, equitable, and in which the teacher involved them in investigations. Chionh and Fraser (1998) used actual and preferred forms of the WIHIC to further validate the instrument and to investigate associations between actual classroom environment and outcomes. The associations between five different

outcome measures namely, examination results, self-esteem, and three attitude scales and the seven actual classroom environment scales were investigated in geography and mathematics classrooms in Singapore and Australia. The study revealed that better examination scores were found in geography and mathematics classrooms where students perceived the environment as more cohesive. It was also found that self-esteem and attitudes were more favourable in classrooms perceived as having more teacher support, task orientation and equity.

2.2 Previous studies investigating differences in students' perceptions on the WIHIC

Several studies involving the WIHIC were conducted outside the USA. For example, gender-related differences in students' perceptions of their learning environment and teacher behaviour were explored by Kim, Fraser, and Fisher (2000). The study involved 543 grade 8 students in 12 different secondary schools in metropolitan and rural areas of Korea. Statistically significant differences were found between boys and girls on all seven scales. It was reported that boys perceived more Teacher Support, Involvement, Investigation, Task Orientation, and Equity than did girls.

In examining education systems in different contexts and cultures, there is a suggestion that there are some fundamental differences in approaches. Schools in Asia are more examination-oriented and teachers are seen as authority figures. As such, students from an Asian background seem to perceive their learning environments differently compared with students from other cultural backgrounds (Fisher & Rickards, 1998; Rickards, 1998). In an attempt to explore the potential of cross-cultural studies, Fraser and Aldridge (1998) examined classrooms in Australia and Taiwan using English and Chinese versions of the WIHIC. The results showed that students in Australia consistently viewed their classroom environment more positively than did students in Taiwan. Significant differences were detected on the

WIHIC scales of Involvement, Investigation, Task Orientation, Cooperation, and Equity. Thus, students in Australia perceived that they are given more opportunity to get involved in the experiments and investigate scientific phenomena. They also have an opinion that teachers are cooperative and give an equal chance of participation to both genders. It appeared that the education system in Taiwan was more examination-driven and teaching styles were adopted to suit that particular situation. It was also found that in Taiwan the most important element of being a good teacher was perceived as having good content knowledge, but in Australia, having good interpersonal relationships between a teacher and their students was considered the most important element in the education process. The study indicates that the WIHIC is useful for differentiating between cultural differences in the classroom environment and therefore might be suitable for a study on multicultural classes, as is the case for the sample used in the present study.

Aldridge, Laugksch & Fraser (2004) compared students' perceptions on the WIHIC between South Africa and Australia. Their study showed that students in South Africa perceived a greater degree of investigation opportunities in their science classrooms than did Australian students, while students perceived less cooperation and equity in South Africa than did students in Australia.

In summary, it seems that in most studies conducted outside the USA boys have a consistently more positive view of their classroom environments than do girls. The only exception is the Equity dimension, where mixed results have been found with respect to gender differences. Consistent differences have also been found with respect to student ethnicity: students from a home culture perceived their classroom environments more positively than students originating from other cultures.

As noted in the Rationale section, there is a number of studies using the WIHIC carried out in the USA. The majority of these studies were conducted in primary

education. Macdowell-Goggin and Fraser (2004), for example, investigated the effects of technology on primary education students' perceptions of their science learning environment with 860 student in Miami. They found strong associations between most of the WIHIC scales and students' experienced pleasure in science. James and Fraser (2004) investigated the effects of an early intervention program for students at risk. Their study also pertained to primary education and was carried out in Georgia. A third study (e.g. Pickett & Fraser, 2004), conducted in the Miami area, showed that teacher training changed students' perceptions of their learning environment in terms of the WIHIC positively. Yet another Miami-based study was carried out by Allen and Fraser (2002), who compared primary education students' and their parents' perceptions on the WIHIC and reported similar perceptions by both groups. However, none of these studies investigated associations between student, teacher and class characteristics and students' perceptions of their learning environment. A small number of the WIHIC-studies carried out in USA primary education classes did investigate the effects of some of these background variables. Soto-Rodriguez and Fraser (2004) also established relationships between student outcomes, both cognitive and affective, and students' perceptions of the learning environment as established with the WIHIC. Their sample was composed of primary education students from Miami. In their study, the researchers discovered that students of limited English proficiency had less favourable views of their learning environment than did students with sufficient proficiency. Orange and Fraser (2004), researching primary education schools in the Washington DC metropolitan area, found differences between disabled students in integrated classes and disabled students in separate classes in their perception of the learning environment as measured with the WIHIC. Disabled students in integrated classes viewed their science classes more favourably than did disabled students in separate classes. Two WIHIC studies conducted in the USA were found that actually pertained

to secondary education. Hoffner Moss and Fraser (2002) investigated biology classes in North Carolina. Their results indicated that boys perceived more involvement and investigation than did girls, and that students from higher grade levels perceived more cooperation than did students from lower grade levels. Finally, their study showed no statistically significant differences in perceptions between black and non-black students. Taylor and Fraser (2004) focussed on secondary mathematics classes in Southern California. Their results indicated that girls perceived more student cohesiveness, task orientation, cooperation and equity than did boys. According to the authors, these findings are consistent with other WIHIC studies. The review presented in this article, however, shows a mixed picture with respect to the effects of gender on students' perceptions of their learning environment.

Thus, all but two of the WIHIC-related studies in the USA were limited to primary education and investigated the effect of background characteristics of students, classes and teachers on the perceptions of students only to a limited degree. These studies showed mixed outcomes with respect to student gender and grade level and no effects of ethnicity. Moreover, all studies employed regular analyses of variance, investigating only one background variable at a time and ignoring the effects of non-random sampling.

Apart from the above mentioned studies, others have investigated the influence of background factors on students' perceptions in the USA with other instruments, such as the *Questionnaire on Teacher Interaction* (e.g. den Brok, et al., 2002; 2003: Levy, et al., 1992; 2003). This work, actually using multilevel analysis and taking into account some of the previously described methodological limitations, showed that, in the USA, girls on average have more favourable views of their learning environment than do boys, and that White and Hispanic-American students have more favourable views

than Asian-American and native-American students. However, this work did not include any variables related to socio-economic background of the students.

3. Research Questions

This was the first large study in California using the WIHIC with eighth-grade science classes. While research exists for *individual* ethnicity and classroom performance (see previous section), it is not known by the authors whether or not research has been done concerning the effect of school composition variables – like ethnic diversity or mean socio-economic status – on students' perceptions. Likewise, since Fraser (1998) has established that students' perceptions of their classroom environment can affect student achievement and attitude to class, it is important to determine if the WIHIC can be used to discriminate between those factors and associations that may influence these perceptions. Also, examining students from a school perspective is a unique approach different from looking at individual status. This resulted in the following research questions for the study:

1. *To what degree do students' perceptions of their learning environment, in terms of WIHIC scales, differentiate between schools and teachers? To what degree are these perceptions idiosyncratic?*
2. *In what way are students' perceptions of their learning environment, in terms of WIHIC scales, determined by their cultural and socio-economic background, or by class and school representatives of these variables?*

4. Design and Procedure

4.1 Sample

The study involved a sample of 655 students from 26 grade eight science classes from 11 Californian schools. All schools in the sample were located in the county of

Monterey, in the central part of California, and were selected due to travelling and time constraints of the fourth author, the primary researcher collecting the data. Calls were made to each of the 18 middle schools in the county and letters were sent to the principals and all science teachers within these schools. Out of these 18 schools, 11 schools indicated their willingness to participate and were included in the study. Schools and teachers within these schools participated on a voluntary basis and individual teachers only received a small incentive – a chocolate bar and a report of their personal outcomes - for their participation. Not all science teachers within each schools participated. Up to 4 teachers from one single school responded positively, with one school being represented by only a single teacher and 4 schools represented by 2 and by 3 teachers respectively. Each teacher was asked to select one class of their personal choice. As a result, our sample consists of teachers and schools that are relatively open to evaluation of their classroom, which limits further generalization to some degree.

The sample used was relatively heterogeneous in terms of ethnic makeup: 20.7 percent of the students indicated to perceive themselves as Latino/Hispanic, 15.9 percent as Afro-American, 0.9 percent as Native-American, 14.2 percent as Asian, 35.0 percent as White- or Caucasian-American and 13.4 percent as Other. Of the sample, 48.7 percent of the students were male. Most of the teachers were female (11 out of 18). Compared to the total population of Californian students in 2001 (the year the data was collected) the sample contained less Hispanic students (43.2 percent in population), more African-American students (8.4 percent in population) and more "other" students being neither White, Indian-American, African-American, Asian or Hispanic (0.6 percent in the sample). Overall, ethnic makeup of our sample is significantly different (Chi-squared=159.85 with df=5; p=.000) from that of the Californian population of students.

None of the schools contained less than 20 percent non-white students or less than 20 percent students receiving a meal at school. While the percentages of non-White students varied between schools from 21 to 100 percent, most schools contained between 21 and 40 percent non-White students, almost a quarter of the schools contained between 81 and 100 percent non-white students. The percentage of students receiving a meal at school varied between 21 and 80 percent in the sample; in total 46.3 percent of the students received a meal. A t-test comparing the percentage of free meals of our sample to the population (t=.44; p=.667) showed that this percentage was similar to that in the state of California (being 46.8 percent). Average class size in the sample was 25.8, which seems close to the state average class size for 8th grade classes (26.9) and the state average class size for science classes (being 29.3 regardless of grade level). Nevertheless, a t-test comparing sample and population indicated that average class size was not representative to the state average class size for 8th grade classes (t=-3.31; p=.001) and to the state average class size for science classes (t=-27.73; p=.000). Thus, it appeared that our sample was different from the state of California population with respect to some of the variables involved.

4.2 Instrumentation

To assess students' perceptions of their learning environment, the WIHIC was administered to all students of participating classes and schools. The WIHIC contains 56 items that are answered on a five-point Likert-type Scale. The items refer to 7 scales. For each scale, Table 2 presents a typical item.

Table 2 about here

Since this study was the first to use the WIHIC on a Californian and middle school sample, several analyses were done to investigate the quality of the outcomes. First, an examination of whether scales had been measured reliably was conducted by computing a Cronbach's Alpha reliability coefficient at the student and class (aggregated) level. The findings of these analyses are given in Table 3. Secondly, the degree to which scales of the WIHIC were able to differentiate between classes was examined by computing an intra-class coefficient. The intra-class coefficient represents the ratio between the amount of variance at the class (and school) level and the student level and can be computed using multilevel analysis of variance (Snijders, & Bosker, 1999). Thirdly, the consistency of each of the WIHIC scales was determined by computing Multilevel Lambda (Snijders, & Bosker, 1999). Lambda is based on both the reliability and intra-class correlation coefficients and represents the degree to which the instrument is capable of measuring consistently across classes.

Table 3 about here

From Table 3 it can be seen that all scales display a high degree of reliability. Reliability coefficients range between .77 (Student Cohesiveness) and .89 (Teacher Support and Cooperation) at the student level, and between .78 (Student Cohesiveness) and .96 (Teacher Support) at the class level. These coefficients are comparable to those presented by other researchers, such as Dorman (2003), reporting coefficients between .76 and .84 at the student level and between .81 and .94 at the class level.

Intra-class correlation coefficients are rather low, ranging from .02 (Student Cohesiveness and Task Orientation) to .18 (Teacher Support). These findings suggest that several scales, such as Student Cohesiveness, Task Orientation, Involvement,

Investigation and Cooperation, are hardly able to distinguish between classes and/or schools, at least with respect to the sample in this study. The Teacher Support and Equity scales are most sensitive for indicating differences between classes. It seems as if most of the variance in the WIHIC scales (over 90 percent) pertains to differences between individual students, rather than differences between classes or schools. While these findings are rather low compared to those reported for other learning environment instruments (e.g. Fraser, 1998), studies using the WIHIC in USA primary education samples did show low amounts of scale variance at the class level as well. For example, a study on primary education students in Georgia (James, et al., 2004) indicated statistically non-significant amounts of variance at the class level for Cooperation, Equity, Student Cohesiveness and Involvement; a study on primary education students in Florida (MacDowell, et al., 2004) indicated non-significant amounts of variance at the class level for Student Cohesiveness, Involvement, Equity and Investigation. In all cases, percentages of variance at the class level were close to or below 5 percent and 15 percent at maximum. Moreover, in secondary education samples using the WIHIC outside the USA percentages of variance (at the class level) below 10 percent have been reported for most scales. Dorman (2003), for example, reports percentages of variance at the class level for a cross-national sample involving students from Australia, the United Kingdom and Canada between 6 (Involvement) and 12 (Teacher Support) percent. Moreover, the low percentages of variance seem to resemble similar findings with respect to student views on climate and affective outcomes in school effectiveness research (Creemers, 1994; Reynolds, 1995; Scheerens & Bosker, 1997), where the majority of the variance in such variables has been reported at the student level, and percentages around or below ten percent pertained to the class and teacher levels.

The low intra-class correlations might not only be the result of sample or instrument characteristics. The method employed in this study to check for validity was also different from those used in earlier research: multilevel analysis instead of one-way analysis of variance was utilised. Further, research using multilevel analysis on other USA samples, especially in secondary education, may be able to verify the stability of these findings. Nevertheless, it seems not completely illogical that scales relating to the relationship dimension (Moos, 1979) – a dimension that is explicitly conceptualised at the group level – display higher intra-class correlations or percentages of variance at the class level than do scales relating to the personal growth dimension. It may be that such elements of the learning environment – although determined and influenced by teacher or class factors as well – are perceived as more idiosyncratic features than other elements. Qualitative research methods, such as interviews with teachers and students, or videotaping of classrooms, might shed light on this issue.

Due to the low intra-class coefficients, consistency of the data is also low for a number of scales. Again, Teacher Support, Equity and to some degree Cooperation seem to have been measured rather consistently across classes, while this is less true for the other variables.

A further analysis of the quality of measurement involved a principal components factor analysis with varimax rotation. The results of this factor analysis (which are not presented in this paper) confirmed that the a priori seven-factor structure was replicated, with all items having a factor loading greater than 0.34 on their own *a-priori* scale and lower factor loadings on the other scales. Additionally, a confirmatory factor analysis was conducted with LISREL, similar to analyses conducted by Dorman (2003) on the WIHIC. This analysis tested the fit of a factor model with the items assigned to their a-priori scales. Fit of this model, that allowed no correlations between the seven

scales, was adequate (RMSEA=.048; GFI=.97; TLI=.96). Thus, the seven-scale structure of the WIHIC was confirmed.

Finally, correlations between the WIHIC scales were computed, in order to see whether they referred to distinctively different aspects of the learning environment. These correlations are presented in Table 4. As can be seen, the scales seem to measure distinct aspects, but also show some overlap. This is particularly true for Involvement and Teacher Support (.45 at the student and .81 at the class level), for Investigation and Teacher Support (.38 at the student and .71 at the class level), and for Task Orientation and Involvement (.52 at the student and .61 at the class level). Despite some of these high correlations, on average most correlations were sufficiently low to assume separate and distinctive elements. This was further supported by results of the confirmatory factor analysis, where a model with no correlations specified between the scales seemed to fit the data. It was therefore concluded that in most cases the scales represented different elements and could be treated as separate concepts for further analyses.

Table 4 about here

Several other variables were included in this study. Students were asked to indicate their *self-perceived ethnic group membership* (Latino, African-American, Asian, Native-American, White-American or Other), and their gender. Also, teachers were asked to indicate their gender. Socio-economic status at the school level was determined by examining free and reduced lunch percentages. Racial Diversity for each school was determined through county demographics, which listed ethnicity percentages for all schools within the county's jurisdiction. Racial diversity of the school was coded in terms of 5 categories, with a score of 1 referring to a percentage of between 0 and 20

percent of non-White students, a score of 5 referring to a percentage of between 80 and 100 percent non-white students. Similar percentage scores were also used for the school socio-economic variable.

Table 5 presents minimum and maximum scores for each of the explanatory variables included in this study, as well as the average score and standard deviation found in the sample.

Table 5 about here

4.3 Data Analyses

To find an answer to the research questions, hierarchical analysis of variance (multilevel analyses) was conducted, using MLN for Windows. It is believed that this was the first WIHIC study to employ multilevel analysis. Multilevel analyses take into account that the data may have not been randomly sampled and allow for multiple variables at different levels to be included at the same time in one analysis. Since it may be assumed that the responses of students that share a similar history, experience and class background are more alike compared with those of students from different classes, regular analyses of variance tend to overestimate the effects of variables (e.g. Hox, 1995). This may be particularly true for the sample of this study, given the fact that schools, teachers and classes were not selected randomly but hierarchically, based on voluntary participation and time constraints, which limits variation and increases correlation.

In the analyses, three levels of variance were distinguished: a student level, a teacher/class level and a school level. Although several classes participated within each school, it should be noted, however, that the ratio between the number of schools and the number of classes is not optimal. In fact, due to the low number of schools

(and classes) most of the estimated variances and coefficients contain some degree of uncertainty. Standard estimation procedures in multilevel analyses programs, such as Iterative Generalized Least Squares (IGLS), often produce biased estimates of coefficients and variance distribution, especially when small numbers of units are available at the higher levels (Luyten & De Jong, 1998). Because of the small number of schools and classes involved in this study, it was decided to use the Restricted Iterative Generalized Least Squares (RIGLS) method, which is suitable for small numbers of units at the highest levels (Goldstein, 1995). Nevertheless, coefficients should be interpreted with care and regarded as tentative; future research involving a larger samples with more schools and classes participating within each school is necessary to confirm the results of the present study.

Analyses were conducted in two steps and were done separately for each of the WIHIC scales. To answer the first research question, referring to the amounts of variance located at each of the three levels, we formulated an empty model (with no explanatory variables), that provided a scale mean for the sample and estimates of variance at the student, class/teacher and school level. The second step consisted of entering the explanatory variables into the models. Next, variables displaying non-significant relationships were removed from the models. For each of the significant variables, apart from regression coefficients and standard errors, we also computed effect sizes.

Variables entered in the second step of the analyses were:

- at the *student level*: student gender, ethnic background (Latino/Hispanic, African-American, Native-American, Asian, White, Other);
- at the *class level*: teacher gender, class size, percentage of boys in class, percentage of Latino/Hispanic students in class, percentage of African-

American students in class, percentage of Native-American students in class, percentage of Asian students in class, number of different cultures in the class;

- at the *school level*: socio-economic background, racial diversity.

Gender and the student ethnic background variables were entered as dummy variables (with boys representing the baseline and girls the score of 1; for the cultural groups 1 referred to the particular cultural group, White students were used as the baseline). The student gender and ethnic background variables were also used to create the class composition variables mentioned above.

5. Results

The results for the empty models, providing the amount of variance present at the school, class and student levels (research question 1) are displayed in Table 6.

Table 6 about here

The outcomes presented in Table 6 reflect those given in Table 3. It can be seen that most of the variance is located at the student level, with some variance at the class level and hardly any variance at the school level. For the Teacher Support and Equity scales, fair amounts of variance relate to class variables, while there is some distinction between schools with respect to Cooperation. These results indicate that, while student perceptions are determined for the larger part by student characteristics, for some elements of the learning environment, there are also distinct differences between teachers or classes, and even between schools. Table 6 also shows that, on average, students perceive high amounts of Student Cohesiveness, Task Orientation, Cooperation and Equity, but low amounts of Teacher Support, Involvement and Investigation.

The second research question deals with the amounts of variance that can be explained (or degree to which perceptions can be predicted) by the variables included in this study. Student, class and school characteristics as included in this study, are only associated with WIHIC scale scores to a limited extent. The outcomes relating to the effects of variables on the WIHIC scale scores are given in Table 7.

Table 7 about here

Student gender appears to be related to four scales: Student Cohesiveness, Teacher Support, Task Orientation and Cooperation. For all of these scales, girls have statistically significant higher ratings than boys, indicating that they have a more favourable perception of the learning environment.

Student ethnicity is not related to any of the scale scores in itself, but the class-makeup variables that are constructed out of these variables are. The percentage of Latino/Hispanic students is somewhat negatively related to the amount of Cooperation perceived. This means the more Hispanic students that are present in the class, the less favourable the class perception of Cooperation is. The percentage of African-American students in class is somewhat negatively related to Involvement and Cooperation. The percentage of Native-American students in class is slightly positively related to Student Cohesiveness. However, given the low number of Native students present in the sample, this finding only has limited significance. The percentage of "other" students in class is negatively related to cooperation. The number of cultures in a class is positively related to Student Cohesiveness: thus, the more different cultures in a class, the more Student Cohesiveness is perceived.

Class size is positively related to Investigation: in larger classes students perceive a little more Investigation. Finally, *teacher gender* is related to Student Cohesiveness and Investigation: for female teachers higher ratings are reported for these scales.

When looking at the effect sizes, it can be seen that teacher gender is relatively stronger associated to students' perceptions than student gender or class composition variables. Class size also seems relevant looking at its effect size. For cooperation, the percentage of Hispanic and African-American students is relatively important, when compared to student gender or the percentage of "other" cultures in the class.

The models explain less than 7 percent of the total variance in each variable. This means that other variables than the ones used in the study are responsible for differences in student perceptions. Overall, the variables do explain much of the variance at the teacher/class level of most of the scales, and only small parts of the student variance. This means that the gender and ethnicity makeup of a class explain to a large degree how a class will perceive its learning environment. Variables hardly explain any variance for Teacher Support, Involvement, Investigation and Equity, though some variance is explained for Cooperation (7.3 percent) and Student Cohesiveness (3.4 percent). No interaction effects between variables were found.

6. Discussion

This research has provided further evidence on the validation of the WIHIC, which assesses seven scales of student perceptions of the classroom environment. The WIHIC for use with this sample was shown to be valid and reliable. However, its ability to distinguish between Californian multicultural classes, teachers or schools was found to be limited with respect to a number of scales, such as Student Cohesiveness, Task Orientation and Involvement. While similar problems were reported in previous studies investigating primary education samples in the USA, research studies using the WIHIC

in other countries always show considerable amounts of variance at the teacher/class level for all scales. Therefore, these outcomes may be related to the American context, but they may also be related to sample characteristics and the method of analysis. Future research is needed to determine whether the limited capacity of some WIHIC scales to distinguish between classes found in this study is typical. Such research could include qualitative data sources (interviews, observations) as well and could help in determining whether some of the learning environment elements of interest perhaps are more perceived in an idiosyncratic manner and other features are more likely to be shared.

This study is the first to provide associations between gender, attitude, racial diversity, ethnic origin, socio-economic status and perceptions on the WIHIC in eighth-grade classes in California. As a result, it has provided the first validation data for the WIHIC in secondary science classes in California and may serve as a starting point for other studies in the same area. Also, it was the first study to investigate the effects of these variables jointly; to estimate their effects after correcting for the presence of and overlap with other background variables.

A number of interesting findings were reported. First, it was found that girls perceive their learning environment more positively than do boys in those same science classes. This finding was somewhat surprising, since earlier studies using the WIHIC indicated the opposite (e.g. Khoo & Fraser, 1997; Kim, Fisher, & Fraser, 2000). Of course, different methods of analyses and the context or country of study might help to explain this. On the other hand, research with other learning environments instruments, such as the *Questionnaire on Teacher Interaction (QTI)* has also indicated that girls have a more favourable perception of their science class learning environment (e.g. den Brok, Levy, Wubbels, & Rodriguez, 2003; Goh, & Fraser, 1995;

Levy, den Brok, Wubbels & Brekelmans, 2003; Levy, Wubbels, & Brekelmans, 1992; Rickards, 1998; Wubbels & Levy, 1993).

Second, the fact that several class ethnic makeup variables displayed a significant effect was also a finding that had not been reported previously. Earlier work using the WIHIC never used such variables. A study investigating the effects of class makeup with the QTI did report that classes with many Asian-American students had more favourable perceptions of the learning environment. An important finding in the present study was the positive association that occurred between the number of ethnic groups in the classroom and their perception of Student Cohesiveness. Apparently, classes without any dominant groups but a high degree of diversity are important for a students' belonging. Chances are that students that are not part of a dominant group may feel themselves isolated.

Third, class size was positively related to Investigation. This seems logical, as teachers have less time to help students on an individual basis in larger classes, which means students have to find things out more by themselves. Finally, teacher gender was related to a number of scales, with classes taught by female teachers displaying a more favourable picture. Again, this finding has not been investigated in other WIHIC studies. However, similar patterns have been found in research using the QTI (e.g. Levy, et al., 2003).

Limited amounts of variance were reported and explained for the class and school level. While this finding was contradictory to earlier WIHIC studies, it might be related to the differences in methodology and characteristics of this particular sample (see Instrumentation section). However, other studies employing multilevel analyses on learning environments instruments indicate similar findings (e.g. den Brok, 2001; den Brok, Levy, Rodriguez, & Wubbels, 2002; Levy, et al., 2003).

Unfortunately, the study was subject to a number of limitations, some of which have been mentioned before. The sample was only representative of the larger population of Californian students with respect to the number of free meals, but was not representative with respect to variables such as ethnicity and average class size. Moreover, the sample was relatively small, in particular with respect to the number of classes and schools surveyed. Although the relatively small sample size was taken into account in analysis estimation procedures (e.g. RIGLS), this may have led to some uncertainty in the estimation of regression coefficients. Therefore, outcomes should be interpreted with care and regarded as tentative. Future research conducting multilevel analyses on larger and other American samples will be necessary to verify the stability of these findings.

This study has several implications. First, it has been shown that class composition may be of importance in creating a suitable, safe and effective learning environment. Schools can affect students' perceptions and school career to some degree by making sure that students are placed in such a way that no single ethnic group (or any group in terms of other student characteristics for that matter) is dominant in terms of numbers. This means that schools should create classes that are medium in size (note the effect of class size on student ratings in this study) and that contain students from as many different countries and backgrounds as possible. Although many parents and students – and even teachers - may be inclined to favour classes containing many students that are alike in terms of background, such classes seem less fruitful in terms of creating an optimal learning environment from the perspective of the students. To realize such group compositions, ultimately, agreements between schools on student placement may be necessary. Diversity might be used as a tool to create a favourable, rich and cohesive learning environment. Secondly, teachers should realise that their efforts may be perceived differently by different students (e.g. girls or boys, students

from different ethnic groups or socio-economic backgrounds). Knowledge on how perceptions are affected by these characteristics may be relevant to affirm certain groups in the classroom and provide knowledge on how a teacher comes across. This is especially important, because research has shown that students' perceptions are strongly related to their educational outcomes, even more so than teacher perceptions or perceptions of external observers (Fraser, 1998; Wubbels & Levy, 1993). For researchers, it may be important to test more rigorously whether their instruments are able to effectively discriminate between classes and/or schools in their specific sample, even if such capability has been demonstrated before on other samples or in other contexts.

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Table 1
Scale descriptions for each scale in the WIHIC Questionnaire.

WIHIC scale	The extent to which...	Moos dimension
Student Cohesiveness	...students are friendly and supportive of each other.	Relationship
Teacher Support	... the teacher helps, befriends, and is interested in students.	Relationship
Involvement	... students have attentive interest, participate in class and are involved with other students in assessing the viability of new ideas.	Relationship
Investigation	..there is emphasis on the skills and of inquiry and their use in problem-solving and investigation.	Personal growth
Task Orientation	... it is important to complete planned activities and stay on the subject matter.	Personal growth
Cooperation	... students cooperate with each other during activities.	Personal growth
Equity	... the teacher treats students equally, including distributing praise, question distribution and opportunities to be included in discussions.	System maintenance and change

Table 2
Typical items for the WIHIC scales.

Scale	Typical item
Student Cohesiveness	I work well with other class members.
Teacher Support	The teacher helps me when I have trouble with the work.
Involvement	I give my opinion during class discussions.
Investigation	I find out answers to questions by doing investigations.
Task Orientation	I know how much work I have to do.
Cooperation	When I work in groups in this class, there is teamwork.
Equity	I am treated the same as other students in this class.

Table 3
Reliability (alpha), intra-class coefficients (ICC) and consistency (Lambda) of WIHIC scales.

Scale	Alpha (student)	Alpha (class)	ICC	Lambda
Student Cohesiveness	.77	.78	.02	.34
Teacher Support	.89	.96	.18	.84
Involvement	.86	.89	.05	.53
Investigation	.88	.92	.06	.53
Task Orientation	.84	.84	.02	.34
Cooperation	.86	.91	.07	.63
Equity	.89	.93	.12	.77

Table 4.
Correlations between WIHIC scales[a].

	Cohes	Supp	Involvm	Investig	Task Or	Coop	Equity
Cohes		.37	.43	.27	.38	.54	.27
Supp	.28		.45	.38	.31	.32	.38
Involvm	.45	.81		.52	.26	.37	.27
Investig	.20	.71	.69		.33	.33	.22
Task or	.37	.52	.70	.61		.42	.40
Coop	.44	.44	.59	.42	.46		.39
Equity	.31	.66	.61	.43	.61	.58	

[a] Within-class correlations are given above the diagonal, while correlations at the teacher-class level are given above the diagonal.
Cohes= Student Cohesiveness; Supp = Teacher Support; Involvm = Involvement; Investig = Investigation; Task Or = Task Orientation; Coop = Cooperation; Equity = Equity.

Table 5
Descriptive statistics for variables used in the study.

Variable	Minimum	Maximum	Mean	Standard deviation
Student gender	0	1	-	-
Latino	0	1	-	-
African-Am.	0	1	-	-
Native-Am.	0	1	-	-
Asian	0	1	-	-
White-American	0	1	-	-
Class size	15	30	26	3.25
% boys in class	35	73	51	9
% Hispanics in class	0	82	21	18.9
% Africans in class	3	26	16	6.84
% Natives in class	0	10	9	2.34
% Asians in class	0	29	14	7.69
% Others in class	4	25	14	6.55
Number of cultures	3	6	4.96	.64
Teacher gender	0	1	-	-
School SES	2	4	2.97	.73
School diversity	2	5	3.48	1.15

Table 6
Variance distribution for the WIHIC scales (empty model).

Variable	Mean (st. error)	School (%)	Teacher (%)	Student (%)	-2*Log-likelihood
Student Cohesiveness	3.95 (.04)	0.28	1.12	98.60	1181.85
Teacher Support	2.72 (.14)	0	16.05	83.95	1666.34
Involvement	2.83 (.04)	0.43	0.14	99.43	1627.44
Investigation	2.64 (.06)	0.27	0.80	98.93	1645.79
Task Orientation	4.13 (.05)	0	3.43	96.57	1302.70
Cooperation	3.70 (.09)	3.13	1.04	95.83	1578.46
Equity	3.57 (.17)	0	23.86	76.14	1668.73

Table 7
Outcomes of multilevel analyses on WIHIC scales (significant explanatory variables; standard errors between brackets; effect size after forward slash).

	Student Cohesiveness	Teacher Support	Involvement	Investigation
Mean (=constant)	3.34 (.25)	2.64 (.17)	3.04 (.10)	1.81 (.32)
Effects				
Student gender	.17 (.05) / .0255	.14 (.07) / .014	-	-
% Latino	-	-	-	-
% African	-	-	-1.32 (.53) / -.103	-
% Indian	2.46 (1.22) / .096	-	-	-
% other	-	-	-	-
# of cultures	.09 (.04) / .096	-	-	-
Class size	-	-	-	.03 (.01) / .115
Teacher gender	.13 (.06) / .140	-	-	.23 (.09) / .141
Total % explained	3.35	0.58	0.14	0.12
Explained (%) at				
school	100	0	0	0
teacher	75	0.7	100	100
student	2.3	0.6	1.0	1.3
-2*log-likelihood	1158.88	1661.73	1622.40	1637.15

Table 7 – *continued*.

	Task Orientation	Cooperation	Equity
Mean (=constant)	4.05 (.06)	4.44 (.18)	3.57 (.17)
Effects			
Student gender	.15 (.05) / .020	.16 (.06) / .018	-
% Latino	-.	-1.07 (.20) / -.229	-
% African	-	-2.51 (.60) / -.212	-
% Indian	-	-	-
% other	-	-1.36 (.58) / -.110	-
# of cultures	-	-	-
Class size	-	-	-
Teacher gender	-	-	-
Total % explained	1.14	7.30	0.0
Explained (%) at			
school	0	100	0
teacher	0	71.4	0
student	1.4	3.6	0
-2*log-likelihood	1293.62	1541.82	1668.73