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AUTHOR	Nix, Rebekah K.; Fraser, Barry J.; Ledbetter, Cynthia E.
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ABSTRACT

The validity and use of a new form of the existing Constructivist Learning Environment Survey (CLES) were studied. The comparative student version (CLES-CS) was developed to evaluate the impact of an innovative teacher development program based on the Integrated Science Learning Environment (ISLE) in public and private school classrooms. The CLES-CS, which measures students' perceptions on a 5-point frequency response scale, was administered to 1,079 high school students in 59 classes in north Texas to assess the degree to which the principles of constructivism were implemented in the class taught by the current teacher relative to classes taught by other teachers in the school. Principal components factor analysis with varimax rotation and Kaiser normalization confirmed the a priori structure of the CLES-CS. The factor structure, internal consistency reliability, discriminant validity, and the ability to distinguish between different classes and groups were supported for the comparative cases of the CLES-CS. When an analysis of variance was used to compare students' perceptions of "this" and "other" classes, statistically significant differences were found for some CLES scales. Students whose teachers had attended the ISLE program perceived higher levels of Personal Relevance and Uncertainty of Science in their classrooms relative to the classrooms of other teachers in the same schools. (Contains 22 references.) (Author/SLD)

Evaluating an Integrated Science Learning Environment (ISLE) Using a New Form of the Constructivist Learning Environment Survey (CLES)

Rebekah K. Nix[1,2], Barry J. Fraser[1], Cynthia E. Ledbetter[1,2]
[1]Curtin University of Technology, Australia
[2]The University of Texas at Dallas

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ABSTRACT. The purpose of this paper is to report on the validity and use of a new form of the existing Constructivist Learning Environment Survey (CLES). As part of a larger study, the comparative student version (CLES-CS) was developed to evaluate the impact of an innovative teacher development program (based on the Integrated Science Learning Environment model) in public/private school classrooms. We used a slightly-modified version of the CLES, originally developed by Taylor and Fraser (1991), whose design and orientation are informed by a psychological view of learning that focused on students as co-constructors of their own knowledge. Two response blocks for each of the same 30 items, comprising five scales, are presented in side-by-side columns. The instrument measures students' perceptions on a 5-point frequency response scale of the extent to which certain psychosocial factors (Personal Relevance, Uncertainty of Science, Shared Control, Critical Voice, and Student Negotiation) are evident in 'THIS' and 'OTHER' classroom learning environments. The CLES-CS was administered to 1079 students in 59 classes in north Texas to assess the degree to which the principles of constructivism were implemented in the class taught by their current teacher relative to classes taught by other teachers in their school. Principal components factor analysis with varimax rotation and Kaiser normalization confirmed the *a priori* structure of the CLES-CS. The factor structure, internal consistency reliability, discriminant validity, and the ability to distinguish between different classes and groups were supported for the comparative cases (THIS and OTHER) of the CLES-CS. When an ANOVA was used to compare students' perceptions of THIS and OTHER classes, statistically significant differences were found for some CLES scales. In particular, students whose teachers had attended the ISLE program (THIS) perceived higher levels of Personal Relevance and Uncertainty of Science in their classrooms relative to the classrooms of other teachers in the same schools (OTHER).

1. INTRODUCTION

This paper specifically reports the validity and usefulness of a new comparative student form of the Constructivist Learning Environment Survey (CLES-CS). The overall research design involved evaluating the Integrated Science Learning Environment (ISLE) program in terms of promoting a more constructivist classroom learning environment, improving teachers' attitudes toward information technology, and advancing teachers' conceptual understanding. Data were collected throughout the study to investigate the general question of whether or not teachers' participation in the ISLE program would lead to the teachers' implementation of constructivist learning environments in their respective students' school classrooms. Evidence derived from multiple sources was triangulated to ensure that the data were not contradictory, and therefore more likely to accurately describe the investigated item (Miles & Huberman, 1984). Teacher and student perceptions of dimensions of the learning environment were used as dependent variables in the overall evaluation.

1.1. Integrated Science Learning Environment (ISLE)

Placing new content in personally-relevant contexts is the ultimate challenge of learning. Subjects traditionally perceived as distinct, such as the sciences, are particularly difficult to internalise and to apply in meaningful ways across variable situations. This ability to transfer knowledge and skills is critical in today's changing society. In addition, decisions are no longer black or white, or right or wrong. Choices are typically based on selection from several possibilities. The ability to perceive the 'bigger picture' with innovative critical thinking and creative problem-solving skills is a new requirement for success. To keep up with today's 'Nintendo Generation', educators need a new perspective – *and they need it now!*

The Integrated Science Learning Environment (ISLE) program modelled a constructivist paradigm to help teachers to learn and apply science content through creating a web page based on conceptual understanding represented in concept maps. Real-world applications of relevant information technologies were covertly employed to seamlessly bridge the gap between three traditionally separate milieus, namely, the university classroom, extended field trip, and public/private school classroom. The overarching research goal was to quantify the individual classroom learning environment through different views in terms of whether or not they had changed with the deliberate attempt at reform as presented in the ISLE program.

1.2. Constructivist Learning Environment Survey (CLES)

In response to the need to assess innovative classroom environments, like ISLE, the Constructivist Learning Environment Survey (CLES) was developed with a psychological view of learning that focused on students as co-constructors of their own knowledge (Taylor & Fraser, 1991; Taylor, Dawson, & Fraser, 1995; Taylor, Fraser, & Fisher, 1997). The CLES was selected for use in this study because of its ability to characterise specific dimensions of the constructivist classroom. The five scales (Personal Relevance, Uncertainty of Science, Shared Control, Critical Voice, and Student Negotiation) enable a multidimensional assessment that provides the basis of the research design. Supporting this unique aim, a contemporary study by Allen and Fraser (2002) showed that the same questionnaire could be used to assess young students' and their parents' perceptions of actual and preferred classroom learning environment along the six dimensions of the What Is Happening In this Classroom questionnaire (WIHIC). The design and orientation of the instrument enabled a multi-dimensional assessment of the complex ISLE model.

Of specific interest with respect to this study, Dryden and Fraser (1998) used the CLES to assess the impact of a large-scale Urban Systemic Initiative (USI) aimed at changing high school science instruction toward a more constructivist approach. Unfortunately, the data reflected the state and district focus on increasing examination scores through professional development training with the direct delivery of program-specific information (i.e. content) rather than pedagogy in a general sense (i.e. context). However, the CLES was cross-validated with a large sample of approximately 1600 students in 120 grade 9-12 science classes in the Dallas metropolitan area. It is not only notable that this work was conducted in the north Texas area, but also that it validated use of the CLES with high school students in the same locale in which this study was conducted. Also relevant is the fact that the CLES was used to evaluate the constructivist-oriented reform of science education, as was the purpose of this study.

In the overall study, three modified forms of the CLES were used to assess the perceived degree of constructivist teaching in the university by teachers and the school classrooms by both teachers and their students. The goal was to enable the classroom teachers to quantify the learning environment in terms of whether or not it changed with the deliberate attempt at reform as presented in the ISLE program through different views, as illustrated in Figure 1.

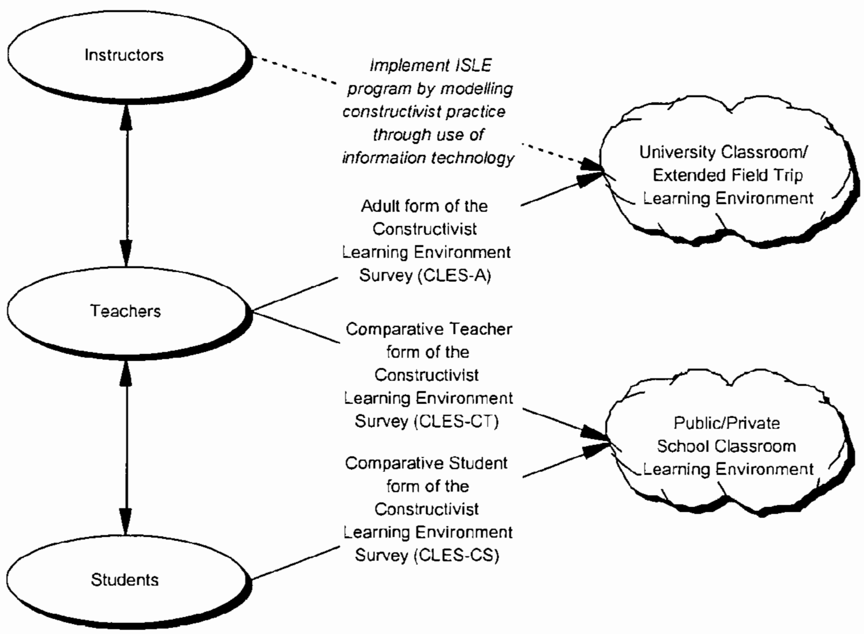

Figure 1. **Multilevel Assessment of ISLE Model Enabled by Three New Versions of the Constructivist Learning Environment Survey (CLES)**

Figure 1 shows how the different participants (university instructors, school teachers, and students) were able to evaluate two different learning environments (university/field trip and school classrooms) using three versions (adult, comparative teacher, and comparative student) of a single learning environment instrument (CLES). The adult form allowed the teachers to assess the degree of constructivist practice in the learning environment which they experienced as students in the university setting. Then, the comparative teacher form allowed the same teachers to assess the degree of constructivist practice in the learning environments which they created as teachers in the school setting. This evaluation was supported by their respective students' assessment of the degree of constructivist practice in the same school classroom learning environment.

Of primary methodological importance, the CLES provides a valid and reliable instrument for the assessment of how teachers' and students' perceptions of constructivist classroom learning environments change with first-hand experience (Fraser, 1998a). The established validity of the CLES was important when selecting it to answer the overarching research question of whether or not a teacher's participation in the ISLE program would lead to the teachers' implementation of constructivist learning environments in their respective students' school classrooms. Consideration was also given to the cultural adaptability of the instrument (Lee & Taylor, 2001) for potential use in future cross-national and longitudinal studies based on the ISLE model. The CLES has been translated and validated for use in Korea (Kim, Fisher, & Fraser, 1999; Lee & Taylor, 2001) and Taiwan (Aldridge, Fraser, Taylor, & Chen, 2000). Of primary theoretical importance, the five scales of this particular learning environment instrument directly support the goals of educational reform in science described in the Adolescence and Young Adulthood/Science Standards (National Board for Professional Teaching Standards, 2001). Table 1 matches the scales of the Constructivist Learning Environment Survey to the Science Learning Environment Standard stated as the primary goals for educational reform in the United States.

Table 1. **Constructivist Learning Environment Survey (CLES) Scales and Learning Environment Goals for Educational Reform in Science**

CLES Scale	Science Learning Environment Standard Statement
Personal Relevance	"Teachers help students learn about and internalize the values inherent in the practice of science by relying on those values to shape the ethos of the learning community."
Uncertainty of Science	"...they (the teachers) work diligently to establish a congenial and supportive learning environment where students feel safe to risk full participation, where unconventional theories are welcomed, and where students know that their conjectures and half-formed ideas will not be subject to ridicule."
Critical Voice	"...teachers recognize that the emotional response of some students to a lively, argumentative, inquiry-based classroom might never to venture an opinion or idea, thereby avoiding the risk of public failure."
Shared Control	"Accomplished science teachers deliberately foster settings in which students play active roles as science investigators in a mutually supportive learning community."
Student Negotiation	"They (the teachers) foster a sense of community by encouraging student interactions that show concern for others, by dealing constructively with socially inappropriate behavior, and by appreciating and using humor."

Quoted from 'Standard V: Learning Environments' (National Board for Professional Teaching Standards, 2001, p. 25)

As evidenced by its widespread implementation, the Constructivist Learning Environment Survey (CLES) is a valuable tool to assist researchers and teachers in assessing the degree to which a classroom's environment is consistent with a constructivist epistemology and to assist teachers in reflecting on their epistemological assumptions and reshaping their practice. Variations of the relatively short and highly appropriate instrument were made to make it suited to assessing both teachers' and students' viewpoints.

2. METHODS AND PROCEDURES

Referring "to the social, physical, psychological, and pedagogical contexts in which learning occurs and which affect student achievement and attitudes" (Fraser, 1998b, p. 3), the field of learning environment research is broad in terms of both substance and methods. Based on the aims of the program and objectives of this study, a multilevel research design was selected to increase the understanding of the emergent model, giving special attention to the influence of the rapidly-developing field of information technology, within the classroom learning environment. To address the multi-faceted aspects of the new Integrated Science Learning Environment (ISLE), the research design was grounded in the naturalistic paradigm (Lincoln & Guba, 1985). The scales of the Constructivist Learning Environment Survey provided a critical scaffold for the development and use of new and revised evaluation resources for use with the ISLE program. In fact, the research methods employed were integrated into the overall design in an overt manner to model the evaluation and assessment of teaching and learning based on the constructivist paradigm.

The combination of qualitative methods and quantitative measures (Fraser & Tobin, 1991) in past studies has provided insight into the integrated milieu and evaluation of the near- and far-term effects of exposure to constructivist pedagogy. Other studies by Aldridge, Fraser, and Huang (1999) and Tobin and Fraser (1998) have successfully combined qualitative and quantitative research methods in studying the classroom learning environment at different 'grain sizes' to show how individual students and the teacher could be investigated also at the class level, school level, or system level. The comprehensive ISLE study was based primarily on quantitative data derived from learning environment dimensions in three modified forms of the CLES. Additional quantitative assessment, through attitude scales and concept map analysis, was supported by qualitative data derived from reflective field journals, interviews, and observations to suggest the impact of the emergent model.

2.1. Comparative Student Form of the Constructivist Learning Environment Survey

We developed a slightly modified version of the original CLES with two response blocks, each of the same 30 items (see Appendix) presented in side-by-side columns. The instrument measures students' perceptions on a five-point frequency response scale of the extent to which certain psychosocial factors (Personal Relevance, Uncertainty of Science, Shared Control, Critical Voice, and Student Negotiation) are evident. The distinct feature of this version of the CLES is that it asks the student to provide perceptions not only of 'THIS' classroom environment (the student's current class), but also of 'OTHER' classroom learning environments (other classes at the same school).

The comparative student version of the Constructivist Learning Environment Survey (CLES-CS) was specifically designed for use with secondary school students. It incorporates some grammatical changes that were carefully made so as to maintain the validity of the original instrument in the new comparative format, which is illustrated below:

I learn about the world outside of school.									
In OTHER classes...					*In THIS class...*				
Almost Never	Seldom	Some- times	Often	Almost Always	Almost Never	Seldom	Some- times	Often	Almost Always

The left, shaded area begins with 'In OTHER classes…', while the right, clear area begins with 'In THIS class…'. The 60-item CLES-CS contains six statements in five scales about practices that could take place in a class or program. Table 2 lists the name and provides a description, along with a sample item, of each scale.

Table 2. **Scale Name, Scale Description, and Sample Items for the Constructivist Learning Environment Survey – Comparative Student (CLES-CS) Form**

Scale Name	Scale Description	Sample Item
Personal Relevance	Relevance of learning to students' lives	I learn about the world outside of school.
Uncertainty of Science	Provisional status of scientific knowledge	I learn that science has changed over time.
Critical Voice	Legitimacy of expressing a critical opinion	It's OK for me to ask the teacher 'why do I have to learn this?'
Shared Control	Participation in planning, conducting and assessing of learning	I help the teacher to plan what I'm going to learn.
Student Negotiation	Involvement with other students in assessing viability of new ideas	I ask other students to explain their thoughts.

2.2. Student Sample and Administration of the CLES-CS

The CLES-CS was administered to 1079 students in 59 classes in north Texas represented by 12 teachers. The sample consisted of a diverse range of age, level, ability, and other demographic characteristics. In general, this assemblage represented nine independent districts, including eight different public schools and two private, parochial schools. With respect to individual classes, the number of students ranged from 5 to 30 per period, while the number of classes taught ranged from 1 to 6 per teacher. The number of students per teacher ranged from 30 to 144 each.

The student data for five ISLE science teachers was comprised of 445 students in 25 classes. It is important to note that these teachers were directly associated with the Master of Arts in Teaching (MAT) program offered through the Science/Mathematics Education Department (University of Texas at Dallas) and had completed the summer 2000 field trip based on the ISLE model. Approximately six months after the final meeting of the ISLE program, the researcher mailed the requested number of surveys to the participating ISLE science teachers for independent administration at their discretion. In this phase, the CLES-CS was administered to 445 students of 5 ISLE science teachers to assess the degree to which the principles of constructivism were evident in specific classroom learning environments within the broader context of the school-level environment.

Unable to pre-determine which teachers might actually complete the ISLE program, the instrument was trialled with potential candidates who had participated in traditional field trips offered by the same instructors in prior years. For comparison purposes, the student data for five science teachers, who had participated in alternative field trips programs, was comprised of 328 students in 19 classes. It is important to note that these teachers also were associated directly with the Master of Arts in Teaching (MAT) program through the Science/Mathematics Education Department (University of Texas at Dallas), but had completed previous MAT field trips that were *not* based on the ISLE model. Coincidentally, one of the teachers surveyed before the ISLE implementation (LH) also participated in the ISLE program. This dual administration not only improved the statistical rigor of the instrument validation (supported by the total sample of 1079 students of 10 science teachers), but also provided a representative control group (328 students of 5 science teachers who had participated in other field trip programs) for comparing the effects of the ISLE model.

The teachers were asked to emphasise that there are no right or wrong answers as the students' opinions were what was wanted. Students were encouraged to think about how well each statement describes what the classes are like for them personally, comparing how often each practice occurred in THIS particular science class to OTHER classes. Students were directed to read each statement and think about lessons they had been taught, indicating the best response for the teaching in OTHER classes in the left column. Then they were encouraged to read the statement again, and think about lessons that they had been taught, indicating the best response for the teaching in THIS class in the right column.

3. RESULTS

The student survey responses were recorded in an electronic spreadsheet by the researchers. To validate the comparative student form (CLES-CS), the responses of 1079 school students were subjected to factor analysis (SPSS for Windows, Release 10.0.5, Standard Version) to check the scale structure. Cronbach's alpha coefficient was used as an index of internal reliability and ANOVA (Gay & Airasian, 2000) was used to check whether each scale was capable of differentiating between the perceptions of students in different classrooms. To compare the students' perceptions of the classroom learning environment fostered by the ISLE teachers to the classroom learning environments fostered by other teachers at their same school, the CLES-CS was administered to the ISLE science teachers' public/private school students (N = 445). Data were examined using a two-tailed *t* test. The effect size (Becker, 1999) was also calculated using the means and standard deviations to portray the magnitude of differences between groups (Rubin & Babbie, 1993).

3.1. Factor Analysis of the CLES-CS

Factor analysis (Kim & Mueller, 1982) is a statistical technique used in data reduction to identify a small number of underlying variables, or factors, that explain most of the variance observed in a much larger number of manifest variables. Using both cases (THIS and OTHER) of the CLES-CS data, factor and item analyses were conducted in order to identify faulty items that could be removed to improve the internal consistency reliability and factorial validity of the five scales in the comparative student version of the CLES. As frequently used in the validation of learning environment instruments, the student data were subjected to principal components factor analysis with varimax rotation (in which the factor axes are kept at right angles to each other) to check the scale structure.

Four items appeared to be problematic for the students: item 6 was reverse-scored; item 7 was negatively-worded; and items 3 and 25 were ambiguously interpreted. Removal of items 3 and 6 in the Personal Relevance scale, item 7 in the Uncertainty of Science scale, and item 25 in the Student Negotiation scale enhanced the reliability and factor structure of the instrument. Following removal of these four items, all of the other 26 items had a factor loading of at least 0.4 on their *a priori* scale and no other scale for the analyses for both THIS and OTHER. Table 3 presents the resulting factor loadings for both cases of the CLES-CS.

Table 3. **Factor Loadings for the Constructivist Learning Environment Survey – Comparative Student (CLES-CS) Form**

Item	Factor Loading									
	Personal Relevance		Uncertainty of Science		Critical Voice		Shared Control		Student Negotiation	
	THIS	OTHER	THIS	OTHER	THIS	OTHER	THIS	OTHER	THIS	OTHER
1	0.66	0.56								
2	0.48	0.44								
4	0.71	0.63								
5	0.63	0.59								
8			0.67	0.63						
9			0.54	0.65						
10			0.44	0.54						
11			0.64	0.68						
12			0.51	0.62						
13					0.60	0.56				
14					0.64	0.60				
15					0.65	0.62				
16					0.48	0.46				
17					0.55	0.51				
18					0.53	0.52				
19							0.66	0.61		
20							0.57	0.57		
21							0.75	0.72		
22							0.71	0.73		
23							0.76	0.74		
24							0.54	0.47		
26									0.62	0.58
27									0.70	0.71
28									0.79	0.75
29									0.69	0.66
30									0.65	0.66
% variance	7.0	5.6	8.0	8.1	8.7	7.5	11.5	10.2	10.3	9.2
Eigenvalue	1.83	1.51	2.06	2.18	2.26	2.02	2.98	2.75	2.67	2.49

N = 1079 students in 59 classes in north Texas. (Items 3, 6, 7, and 25 were omitted.)

THIS refers to the science teachers' current class; OTHER refers to classes taught by other non-science teachers in the same school.

Principal components factor analysis with varimax rotation and Kaiser normalization confirmed the *a priori* structure of the CLES-CS. The percentage of the total variance and eigenvalue associated with each factor are also shown at the bottom of Table 3. The total amount of variance accounted for by the 26 items within the five scales is 45.5% for THIS and 40.6% for OTHER, and ranged from 5.6% to 11.5% for different scales and cases. The eigenvalues range from 1.83 to 2.98 for THIS and from 1.51 to 2.75 for OTHER. Overall, these data provide strong support for the factorial validity of the five-scale comparative student version of the Constructivist Learning Environment Survey (CLES-CS).

3.2. Internal Consistency Reliability and Discriminant Validity of the CLES-CS

Reliability analysis explores the properties of measurement scales and the items of which they are comprised. Cronbach's alpha coefficient was used as an index of internal consistency reliability for each of the scales for two units of analysis (individual and class mean). Table 4 shows that the alpha coefficients of different CLES-CS scales were high, ranging from 0.74 to 0.85 for THIS and from 0.68 to 0.83 for OTHER with the individual as the unit of analysis. Using the class mean as the unit of analysis, scale reliability estimates ranged from 0.87 to 0.93 for THIS and from 0.69 to 0.88 for OTHER.

To assess the extent to which a scale is unique in the dimension that it covers and is not included in another scale in the same instrument, the mean correlation of a scale with other scales, also reported in Table 4, was used as a convenient index of discriminant validity. In the teachers' current classes (THIS), the mean correlation of a scale with the other scales varied between 0.28 and 0.32 with the individual as the unit of analysis and between 0.28 and 0.39 with the class mean as the unit of analysis. In classes taught by other teachers (OTHER), the mean correlation of a scale with the other scales varied between 0.25 and 0.27 with the individual as the unit of analysis and between 0.16 and 0.34 with the class mean as the unit of analysis. These results suggest that each scale assesses a unique dimension and that, while there is some overlap between raw scores on scales, they are relatively independent of each other. Additionally, the factor analysis results support the independence of factor scores.

Table 4. **Internal Consistency Reliability (Cronbach Alpha Coefficient), Discriminant Validity (Mean Correlation with Other Scales), and Ability to Differentiate Between Classrooms (ANOVA Results) for Two Units of Analysis for the Constructivist Learning Environment Survey – Comparative Student (CLES-CS) Form**

Scale	Unit of Analysis	Alpha Reliability		Mean Correlation with other Scales		ANOVA eta^2	
		THIS	OTHER	THIS	OTHER	THIS	OTHER
Personal Relevance	Individual	0.75	0.68	0.29	0.25	0.20**	0.07
	Class Mean	0.91	0.69	0.35	0.22		
Uncertainty of Science	Individual	0.74	0.78	0.32	0.26	0.18**	0.11**
	Class Mean	0.87	0.87	0.39	0.18		
Critical Voice	Individual	0.77	0.74	0.28	0.26	0.12**	0.09**
	Class Mean	0.87	0.80	0.35	0.34		
Shared Control	Individual	0.84	0.83	0.28	0.27	0.12**	0.07
	Class Mean	0.91	0.84	0.28	0.16		
Student Negotiation	Individual	0.85	0.82	0.31	0.27	0.12**	0.10**
	Class Mean	0.93	0.88	0.38	0.29		

** $p < 0.01$

N = 1079 students in 59 classes in north Texas. (Items 3, 6, 7, and 25 were omitted.)

THIS refers to the science teachers' current class; OTHER refers to classes taught by other non-science teachers in the same school.

The eta^2 statistic (which is the ratio of 'between' to 'total' sums of squares) represents the proportion of variance explained by class membership.

3.3. Ability of the CLES-CS to Differentiate between Classes

A desirable characteristic of the actual form of a classroom environment scale is that it is capable of differentiating between the perceptions of students in different classrooms. Students in the same class should see its environment relatively similarly, whereas average class perceptions should vary from class to class. A one-way analysis of variance (ANOVA) was performed for the scores to determine the ability of each CLES-CS scale to differentiate between the perceptions of students in different classrooms. Table 4 reports the results in terms of eta^2, which is the ratio of 'between' to 'total' sums of squares.

The eta^2 statistic provides an estimate of the strength of association between class membership and the dependent variable (CLES-CS scale). The amount of variance in scores accounted for by class membership (eta^2) ranged from 0.12 to 0.20 for THIS and from 0.07 to 0.11 for OTHER in the different CLES-CS scales. The results were statistically significant ($p < 0.01$) for nearly all scales and cases, with the exception of the OTHER case for Personal Relevance and Shared Control. This suggests that nearly all scales of the CLES-CS are able to differentiate between the perceptions of students in different classes.

3.4. Comparison of Classrooms for ISLE Students (THIS versus OTHER)

To show the differences between the students' perceptions of the learning environments in the ISLE science teachers' classroom (THIS) versus the overall environment for other teachers' classroom throughout the same school (OTHER), Figure 2 graphically contrasts the average item mean scores of the CLES-CS using the individual as the unit of analysis. Note that the maximum range of values varies by a total of 1.52 units.

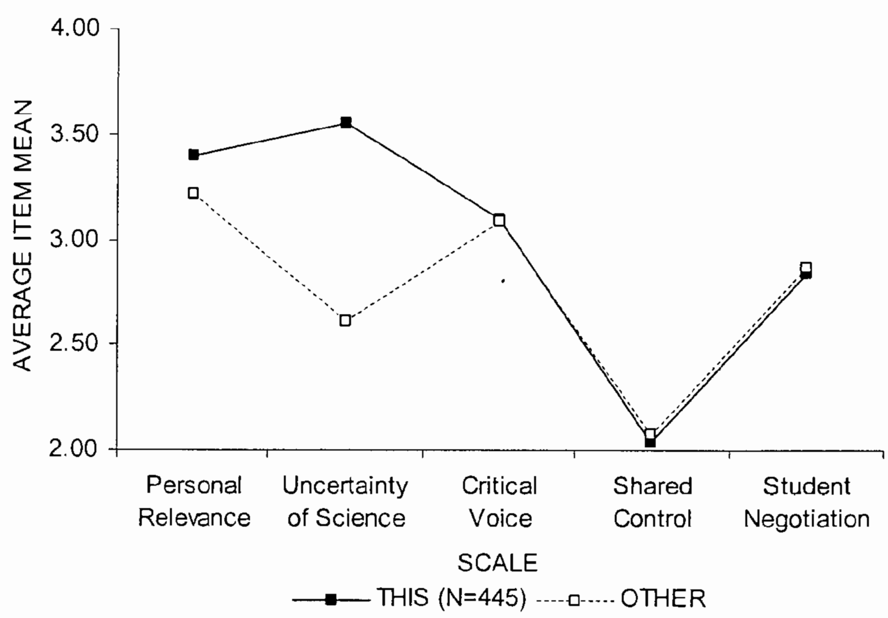

Figure 2. **Students' Perception of ISLE Science Classroom Teaching: Results of the Comparative Student Form of the Constructivist Learning Environment Survey (CLES-CS)**

For the ISLE science teachers' students, differences between the average item mean scores for THIS and OTHER were +0.19 for Personal Relevance, +0.94 for Uncertainty of Science, +0.02 for Critical Voice, -0.04 for Shared Control, and -0.02 for Student Negotiation. The range of these values (from 2.03 to 3.55) indicates that the practices encompassed by all scales of the CLES were perceived by the students to occur with an overall frequency of between Seldom (3.00) and Often (4.00) in the public/private schools for both ISLE science and other teachers.

The small differences between scores for THIS and OTHER on three of the scales of Critical Voice, Shared Control, and Student Negotiation suggest consistent perceptions about administrative policy and classroom management policy. Because this sample was limited to science teachers only, data for the other two scales (Personal Relevance and Uncertainty of Science) were likely to be skewed in the positive direction due to the specific emphasis on science-related content. The average item mean score for Personal Relevance was 3.40 for ISLE teachers and 3.21 for teachers who had participated in other field trip programs. These data suggest that students perceive science as personally-relevant more often than not. The greatest difference in average item mean scores was reported for Uncertainty of Science, ranging from 3.55 for ISLE teachers to 2.61 for teachers who had participated in other field trip programs. These data suggest that the ISLE teachers might present science in a way that demonstrates the uncertainty of science more often than teachers who attended alternative field trip programs.

In order to further investigate the differences in students' perceptions of the constructivist approaches present in their current ISLE science teacher's class (THIS) as compared with other teachers' classes (OTHER), scores were examined using a two-tailed *t* test for dependent samples. Also, the effect size was calculated using the means and standard deviations of two groups (THIS and OTHER) to portray the magnitude of the differences between the groups. Table 5 presents the results for each scale, assuming equal variances.

The data in Table 5 show that differences between the classroom environments of THIS (ISLE science teachers) and OTHER (other teachers in the same school) are statistically significant ($p < 0.01$) for Personal Relevance and Uncertainty of Science. Not surprisingly, this indicates that students perceive the ISLE science classroom as more relevant and uncertain in terms of content. At $p < 0.05$, the difference between THIS and OTHER for Shared Control is also statistically significant, yet in the opposite direction. These data suggest that students of ISLE teachers might not feel as comfortable about opening discussion within the science classrooms as do students of teachers who attended other field trip programs. However, this unexpected discrepancy could likely be attributed to the nature of the subject. For example, literature lessons might be based primarily on group review and interactive dialogue. Science lessons are typically based on experimentation that could be perceived as involving the reporting of concrete information rather than independently formulated hypotheses. This might impact on the students' perceptions of the learning environment in that their questioning and participation are elicited in other classes, while student questioning and participation is inherently enacted in the science classroom.

Table 5. **Average Item Mean, Average Item Standard Deviation, and Differences Between ISLE Science Students' Perceptions of THIS and OTHER Classroom Environments with the Individual as the Unit of Analysis**

Scale	Items	Average Item Mean		Average Item Standard Deviation		Difference	
		THIS	OTHER	THIS	OTHER	Effect Size	*t*
Personal Relevance	4	3.40	3.21	0.84	0.75	0.12	4.50**
Uncertainty of Science	5	3.55	2.61	0.78	0.95	0.48	20.86**
Critical Voice	6	3.10	3.08	0.90	0.87	0.01	0.63
Shared Control	6	2.03	2.10	0.83	0.83	0.04	-2.39*
Student Negotiation	5	2.84	2.86	0.99	0.93	0.01	-0.86

* $p < 0.05$, $t = 1.96$; ** $p < 0.01$, $t = 2.58$ (Items 3, 6, 7, and 25 were omitted.)

N = 445 students in 25 classes taught by 5 ISLE science teachers.

THIS refers to the ISLE science teacher's current class; OTHER refers to classes taught by other teachers in the same school.

The effect size (i.e. the difference between means expressed in standard deviation units) for each scale is also shown in Table 5. The effect sizes range from nearly nothing for Critical Voice, Shared Control, and Student Negotiation (0.04 to 0.01), to approximately one tenth of a standard deviation for Personal Relevance (0.12) and up to almost half of a standard deviation for Uncertainty of Science (0.48). The smaller effect sizes could suggest that the areas over which the administrative units appear to have strict control are resistant to change based on the ISLE program. By the same token, the magnitude of the larger effect sizes suggests that the ISLE program could be having an educationally important effect in improving the learning environment indicators over which the teachers evidently feel they have some control.

Additional qualitative data from the ISLE science teachers' journals support this interpretation. Teacher AC expressed this in the following entry. "Since my curriculum is Life Science and very set, the only things that I could incorporate are the medicine plants and some information on the plants. I would love to figure out how I could incorporate more". Teacher RF echoed this limitation as well. "Although Erosion and Deposition is now supposed to be in 7th grade science, I have much more to use when teaching [about the] Cretaceous period, faulting, igneous rocks, angle of repose, fossilization, chemistry (and its application), volcanoes, dikes, sills, earth history".

As an interesting aside, in contrast, qualitative data for the ISLE non-science participants suggested creative ways in which they might integrate what they learned into their curricula. Teacher GB noted that "I could integrate what I have learned into almost any class, such as, English by reading about environments, dinosaurs and ancient history". The administrator (LL) expressed yet another viewpoint in her statement that "I will use this information to view the upcoming political issues, on pollution, from a much broader perspective".

3.5. Comparison of the Science Classroom Environments of ISLE Teachers with Teachers Who Attended Other Field Trip Programs

Data for the ISLE science teachers' classrooms also were compared to results for the science classrooms of teachers who attended alternative field trip programs. Using the individual as the unit of analysis, Figure 3 graphically presents the average item mean scores for the CLES-CS for teachers who experienced ISLE and for teachers who had a different field trip program experience (ISLE and non-ISLE). The maximum range of values varies by a total of 1.56 units.

Students of the science teachers who attended other field trip programs (non-ISLE) perceived their science classrooms as slightly more constructivist than did students of the ISLE science teachers for two scales (Critical Voice and Student Negotiation). For the science teachers' students, differences between the average item mean scores for ISLE and non-ISLE were +0.37 for Personal Relevance, +0.23 for Uncertainty of Science, -0.17 for Critical Voice, +0.04 for Shared Control, and -0.05 for Student Negotiation. Again, the range of these values (from 2.03 to 3.55) indicates that the practices encompassed by all scales of the CLES were perceived by the students to occur with an overall frequency of between Seldom and Often in science classrooms in the public/private schools for both ISLE and non-ISLE teachers.

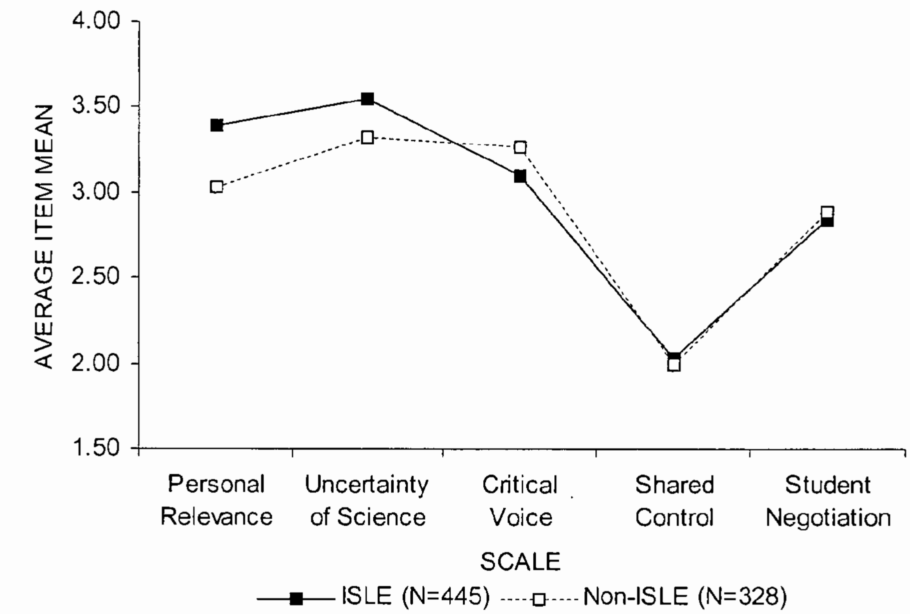

Figure 3. **Students' Perceptions of Science Classroom Environment for ISLE Teachers and Teachers from Other Field Trip Programs: Results for the Comparative Student Form of the Constructivist Learning Environment Survey (CLES-CS)**

Table 6 shows that differences between the science classroom learning environments of ISLE and non-ISLE teachers are statistically significant ($p < 0.01$) for Personal Relevance and Uncertainty of Science. Interestingly, this indicates that students perceive the science classrooms of ISLE teachers as more relevant and the topic more uncertain than do students in classrooms of teachers who attended other field trip programs. This suggests that the differences in these two scales might not be attributable solely to the nature of the course content. In fact, the data indicate that Personal Relevance and Uncertainty of Science scales could have been directly impacted by the ISLE program.

Again, at $p < 0.05$, differences between ISLE and non-ISLE teachers are also statistically significant for Critical Voice, yet in the opposite direction. This surprising difference suggests that students of ISLE teachers might not feel as comfortable about opening discussion within the science classrooms as do students of non-ISLE teachers. However, qualitative data suggest that this unexpected discrepancy could be a consequence of the overall school-level environment. Although the teachers' experience in the science classroom and the average number of students in each science class did not vary considerably, the basic demographics of the schools did differ notably. The non-ISLE science teachers' schools were all characterised by a large total enrolment in urban and suburban settings. In contrast, the ISLE science teachers' represented two small parochial, one medium rural, and only two large suburban schools. This difference in overall demographics might account for the students' different perceptions of the learning environment, particularly reflected in the Critical Voice scale.

Table 6. **Average Item Mean, Average Item Standard Deviation, Effect Size, and Differences Between ISLE and Other Teachers (Effect Size and *t* Test for Independent Samples) on the Constructivist Learning Environment Survey (CLES-CS)**

Scale	Average Item Mean		Average Item Standard Deviation		Difference Between Programs	
	ISLE	Non-ISLE	ISLE	Non-ISLE	Effect Size	t
Personal Relevance	3.40	3.03	0.84	0.96	0.20	5.65**
Uncertainty of Science	3.55	3.33	0.78	0.92	0.13	3.68**
Critical Voice	3.10	3.27	0.90	1.11	0.08	-2.28*
Shared Control	2.03	1.99	0.83	0.94	0.02	0.60
Student Negotiation	2.84	2.89	0.99	1.07	0.02	-0.61

* $p < 0.05$, $t = 1.96$; ** $p < 0.01$, $t = 2.58$ (Items 3, 6, 7, and 25 were omitted.)

N_{ISLE} = 445 students in 25 classes taught by 5 ISLE science teachers; $N_{Non\text{-}ISLE}$ = 328 students in 19 classes taught by 5 non-ISLE science teachers.

ISLE refers to science teachers who participated in the ISLE program; non-ISLE refers to science teachers who participated in a different field trip program.

The effect size for each scale is also shown in Table 6. Using the individual as the unit of analysis, the effect sizes range from nearly nothing for Shared Control and Student Negotiation (0.02), to approximately one tenth of a standard deviation for Uncertainty of Science (0.13), and up to one fifth of a standard deviation for Personal Relevance (0.20). As before, the smaller effect sizes suggest that the areas over which the administrative units appear to have strict control are resistant to change based on the ISLE program. By the same token, the magnitude of the somewhat larger effect sizes suggest that the ISLE program could be educationally important for improving the learning environment indicators over which the teachers' evidently feel they have some control (i.e., Personal Relevance and Uncertainty of Science).

In summary, the data suggest that the ISLE program was effective in terms of the degree of implementation of constructivist teaching approaches in the teachers' public/private school classrooms for the ISLE science teachers, as perceived by their respective students.

4. CONCLUSIONS

Learning environments research has a broad range of applicability for today's diverse educational issues. Development and validation of the comparative student form of the Constructivist Learning Environment Survey (CLES) contributes to a useful range of instruments for a variety of classroom contexts within the burgeoning field of learning environments research. Our study provided another example of the use of learning environment variables in the evaluation of educational programs (Dryden & Fraser, 1998; Maor & Fraser, 1996). The factor structure, internal consistency reliability, discriminant validity, and ability to distinguish between different classes were supported for the CLES-CS (THIS and OTHER) with our sample of 1079 students. The overall results validate use of the CLES-CS with students in public/private schools in north Texas.

Participation in the Integrated Science Learning Environment (ISLE) program provided a tangible opportunity for teachers to gain organised knowledge to make practical changes in their school classrooms. The instructors' ability to match methodology to outcome offers a broad context for enculturation of the constructivist paradigm. Because of the influence of the traditional school-level environment, as Milne and Taylor (2000) reported, this sort of pedagogical change is difficult to realise in individual classrooms. However, if not appropriately implemented, even the best constructivist epistemology is ineffective. The successful development of the comparative student form of the Constructivist Learning Environment Survey (CLES-CS) provides another, complementary means of evaluating the degree to which students feel that the principles of constructivism have been implemented in the class taught by their current teacher relative to classes taught by other teachers in their school.

APPENDIX

Items (Grouped by Scale) on the Comparative Student Form of the Constructivist Learning Environment Survey (CLES-CS)

Item	Statement
Personal Relevance Scale	
1	I learn about the world outside of school.
2	My new learning starts with problems about the world outside of school.
3	I learn how science can be part of my out-of-school life.
4	I get a better understanding of the world outside of school.
5	I learn interesting things about the world outside of school.
6*	What I learn has nothing to do with my out-of-school life.
Uncertainty of Science Scale	
7	I learn that science cannot provide perfect answers to problems.
8	I learn that science has changed over time.
9	I learn that science is influenced by people's values and opinions.
10	I learn about the different sciences used by people in other cultures.
11	I learn that modern science is different from the science of long ago.
12	I learn that science is about creating theories.
Critical Voice Scale	
13	It's OK for me to ask the teacher 'why do I have to learn this?'
14	It's OK for me to question the way I'm being taught.
15	It's OK for me to complain about teaching activities that are confusing.
16	It's OK for me to complain about anything that prevents me from learning.
17	It's OK for me to express my opinion.
18	It's OK for me to speak up for my rights.
Shared Control Scale	
19	I help the teacher to plan what I'm going to learn.
20	I help the teacher to decide how well I am learning.
21	I help the teacher to decide which activities are best for me.
22	I help the teacher to decide how much time I spend on learning activities.
23	I help the teacher to decide which activities I do.
24	I help the teacher to assess my learning.
Student Negotiation Scale	
25	I get the chance to talk to other students.
26	I talk with other students about how to solve problems.
27	I explain my understandings to other students.
28	I ask other students to explain their thoughts.
29	Other students ask me to explain my ideas.
30	Other students explain their ideas to me.

Adapted from Taylor & Fraser (1991)
* Reverse-scored item
The response alternatives are Almost Never, Seldom, Sometimes, Often, and Almost Always.

REFERENCES

Aldridge, J.M., Fraser, B.J., & Huang, T-C.I. (1999). Investigating classroom environment in Taiwan and Australia with multiple research methods. Journal of Educational Research, 93, 48-63.

Aldridge, J.M., Fraser, B.J., Taylor, P.C., & Chen, C.C. (2000). Constructivist learning environments in a cross-national study in Taiwan and Australia. International Journal of Science Education, 22, 37-55.

Allen, D., & Fraser, B.J. (2002, April). Parents' and students' perceptions of the classroom learning environment and its influence on student outcomes. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Becker, L.A. (1999). Testing for differences between two groups: *t* test. In Basic and Applied Research Methods. University of Colorado at Colorado Springs, CO. [On-line.] Available: http://www.web.uccs.edu/lbecker/Psy590/es.htm.

Dryden, M., & Fraser, B.J. (1998, April). The impact of systemic reform efforts on instruction in high school classes. Paper presented at the annual meeting of the American Educational Research Association, San Diego, CA.

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

Fraser, B.J. (1998b). The birth of a new journal. Learning Environments Research, 1, 1-5.

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

Gay, L.R., & Airasian, P. (2000). Educational research: Competencies analysis and application (6th ed.). Upper Saddle River, NJ: Merrill Publishing Company.

Kim, H.B., Fisher, D.L., & Fraser, B.J. (1999). Assessment and investigation of constructivist science learning environments in Korea. Research in Science and Technological Education, 17, 239-249.

Kim, J., & Mueller, C.W. (1982). Introduction to factor analysis: What it is and how to do it. Beverly Hills, CA: Sage Publications.

Lee, S., & Taylor, P. (2001, December). The cultural adaptability of the CLES: A Korean perspective. Paper presented at the annual meeting of the Australian Association for Research in Education, Fremantle, Australia.

Lincoln, Y.S., & Guba, E.G. (1985). Naturalistic inquiry. Beverly Hills, CA: Sage Publications.

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

Miles, M.B., & Huberman, A.M. (1984). Qualitative data analysis: A sourcebook of new methods. Beverly Hills, CA: Sage Publications.

Milne, C., & Taylor, P. (2000, April). "Facts are what you teach in science!" Teacher beliefs and the culture of school science. Paper presented at the annual meeting of the National Association for Research in Science Teaching, New Orleans, LA.

National Board for Professional Teaching Standards. (2001). Adolescence and young adulthood/science standards. Washington, DC: Author. [On-line]. Available: http://new.nbpts.org/standards/complete/aya_science.pdf.

Rubin, A., & Babbie, E. (1993). Research methods for social work (2nd ed.). Pacific Grove, CA: Brooks/Cole Publishing Company.

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

Taylor, P.C., & Fraser, B.J. (1991, April). Development of an instrument for assessing constructivist learning environments. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

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

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

Correspondence concerning this paper should be addressed to:

Rebekah K. Nix
Department of Science/Mathematics Education
The University of Texas at Dallas
PO Box 830688, MS: FN32
Richardson, TX 75083-0688
rnix@utdallas.edu

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Organization/Address: 6631 Lakehurst Dallas, TX 75230	Telephone: (972) 883-2488	FAX: (972) 883-6371
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