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VALIDITY AND RELIABILITY OF A SHORTENED, REVISED VERSION OF THE CONSTRUCTIVIST LEARNING ENVIRONMENT SURVEY (CLES)

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ABSTRACT. The purpose of the study was to investigate the use of an existing instrument, the Constructivist Learning Environment Survey (CLES) (Taylor, Dawson & Fraser, 1995; Taylor, Fraser & Fisher, 1993, 1997), for providing insights into the classroom learning environments of beginning science teachers. In the first year of the study, the CLES was used with 290 upper elementary, middle, and high school science teachers and preservice teachers. As part of a larger study of the classroom environments and teaching practices of beginning science teachers, data also were gathered through classroom observations of and interviews with some of the participating teachers. Exploratory factor analysis and internal consistency reliability analysis, as well as examination of each item and of participants' questions and comments about them, led to a shortened, revised version of the CLES, named the CLES 2(20). The five original scales were retained, but the number of items in each scale was reduced from six to four. The single negatively worded item was eliminated. Some of the original items were rephrased. The revised CLES was then used in the second, third and fourth years of the study. Examples of feedback based on CLES data is provided to researchers to assist them in writing teacher profiles.

KEY WORDS: beginning science teachers, classroom learning environment, Constructivist Learning Environment Survey (CLES), exploratory factor analysis, internal consistency reliability, teacher perceptions

1. Introduction

As educators of future teachers, we have many opportunities to see our students teach during practicum and student teaching experiences, but we rarely get to see what happens after they leave us. How are they really teaching? Simmons et al. (1999) reported a collaborative research project which involved nine teacher preparation institutions and which focused on the alignment of the beliefs and practices of beginning secondary science and mathematics teachers. Teacher interviews, analysis of videotaped lessons, and a teacher and student questionnaire, called the Constructivist Learning Environment Survey (CLES), were used to gather data leading to assertions about teacher knowledge and beliefs, teaching performance, and the comparison of knowledge and beliefs to teaching performance. One of the recommendations resulting from this project was a call for similar

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collaborative studies to ". . . strive to address the needs of students, teachers, teacher educators, and other stakeholders working to establish a common vision for excellent instruction and systemic, long-lasting reform" (Simmons et al., 1999, p. 931).

Educators and policy makers in Minnesota have been working on such reform efforts and are particularly concerned, as are their colleagues nationally, about the high attrition rates of beginning science and mathematics teachers. While there were, and are, many efforts to reform initial teacher preparation in the State, little was known about what actually happens in the classrooms of graduates of these programs. In an attempt to build pictures of the classrooms of these beginning teachers, SciMath[MN], a public-private partnership, funded the Teacher Research Network (TRN)[1] (Davis & Simpson, 2000; Davis, Simpson, Johnson & Wallace, 2002). Science and mathematics teacher educators participated in the design and implementation of a longitudinal study to answer two questions: What are new teachers' current practice, knowledge and beliefs about teaching science/mathematics? What is the context in which new teachers teach science/mathematics? Teacher educators from five public and private teacher preparation institutions participated in the first year of the study. Five more institutions in the State joined for the second, third, and fourth years of the study.

The design of the TRN study began with instruments and protocols developed for the study reported by Simmons et al. (1999). These included an interview instrument, the Teacher's Pedagogical Philosophy Interview (TPPI) (Richardson & Simmons, 1994), a videotape analysis protocol, the Secondary Teacher Analysis Matrix (STAM) (Gallagher & Parker, 1995), and a classroom environment perception instrument, the CLES (Taylor et al., 1993). Additionally, another instrument, the Science Teaching Efficacy and Beliefs Instrument (STEBI) (Enochs & Riggs, 1990), not used in the previous study, was included. The first year of the research was a pilot study which provided a chance to try out the instruments and protocols. Each of the instruments except for the STEBI was subsequently either revised or replaced. This article reports the results of the pilot study and revision of the CLES, as well as a description of its use in writing profiles of beginning science and mathematics teachers.

2. Classroom Learning Environment

The classroom learning environment, sometimes referred to as the educational environment or the classroom climate, is the social atmosphere in which learning takes place. Fraser (1994) regards these learning environments as the social-psychological contexts or determinants of learning. Several studies have indicated that classroom learning environment is a strong factor in determining and predicting students' attitudes toward science (Lawrenz, 1976; Simpson & Oliver, 1990). Talton and Simpson (1987) argued that classroom learning environment was the strongest predictor of attitude toward science in all grades.

While observations of classroom teaching and learning and interviews with classroom teachers can provide valuable insights into the classroom learning environment, they do not tell the whole story. As Barry Fraser explains (Fraser, 2001), student perceptions of the classroom learning environment are important, should be of interest to classroom teachers, and can be fairly easily measured with classroom environment perception instruments. Such instruments also commonly have versions that measure teachers' perceptions of the classroom learning environment.

The Constructivist Learning Environment Survey (CLES) is being used in the present study to assess both teachers' and students' perceptions of classroom learning environments. Originally developed by Peter Taylor, Barry Fraser, and Darrell Fisher at Curtin University of Technology in Perth, Australia (Taylor et al., 1993), the CLES consisted of 28 items, seven each in four scales – Autonomy, Prior Knowledge, Negotiation, and Student-Centredness. The instrument was later revised to incorporate a critical theory perspective (Taylor et al., 1995), resulting in the CLES 1(30) (see Appendix A) that was used in the first year of the present study. This version consists of 30 items, six each in five scales (see Table I). Rather than having items from different scales mixed together throughout the instrument, items in this version are grouped into blocks according to their scale. In addition, there is only one item that is negatively worded. There are versions for both science and for mathematics as well as for teachers and for students. All four versions of the CLES are being used in the TRN study.

The CLES has been used in a variety of studies, including qualitative studies of the nature of science knowledge and learning of science teachers and their students (Lucas & Roth, 1996; Roth & Bowen, 1995; Roth & Roychoudhury, 1993), a study of science education reform efforts in Korea (Kim, Fisher & Fraser, 1999), a study of preservice science teachers' self-efficacy and science anxiety (Watters & Ginns, 1994), a comparison of classroom environments in Taiwan and Australia (Aldridge, Fraser, Taylor & Chen, 2000), a study of secondary preservice teacher beliefs (Waggett, 2001), an investigation of the relationships between classroom environment and student academic efficacy (Dorman, 2001), an action

TABLE I

Scale Description for Each Dimension of the Constructivist Learning Environment Survey (CLES)

Scale	Scale description
Personal relevance	Extent to which school science/mathematics is relevant to students' everyday out-of-school experiences.
Uncertainty	Extent to which opportunities are provided for students to experience that scientific/mathematical knowledge is evolving and culturally and socially determined.
Critical voice	Extent to which students feel that it is legitimate and beneficial to question the teachers' pedagogical plans and methods.
Shared control	Extent to which students have opportunities to explain and justify their ideas, and to test the viability of their own and other students' ideas.
Student negotiation	Extent to which students share with the teacher control for the design and management of learning activities, assessment criteria, and social norms of the classroom.

Note: All scale descriptions are taken from Taylor et al. (1997).

research study of the effects of integrating technology into the classroom (Harwell, Gunter, Montgomery, Shelton & West, 2001), and a multilevel study that also used classroom observations, student diaries, and teacher interviews (Tobin & Fraser, 1998).

Taylor et al. (1997) reported the results of an exploratory factor analysis (EFA). They concluded that the results showed that the proposed factor structure, the five scales of the CLES, held up. They also reported internal consistency results supporting those factors. Taylor et al. (1995) also reported internal consistency reliability coefficients that led the authors to the same conclusions (see Table II). In both studies, the analyses were made using the science student form of the CLES.

3. Methods and Procedures

The longitudinal nature of the TRN study, as well as the involvement of researchers from several different institutions, presented a number of logistical challenges. To make sure that the study was carefully designed,

TABLE II

Alpha Reliability Coefficients for Various Versions of the CLES with Student and Teacher Samples

Scale	Alpha coefficient				
	Australian students		American teachers	American students	
	CLES 1(30)[a]	CLES 1(30)[b]	CLES 1(30)[c]	CLES 2(20)[d]	CLES 2(20)[e]
Personal relevance	0.82	0.70	0.80	0.89	0.90
Uncertainty	0.72	0.61	0.81	0.75	0.81
Critical voice	0.88	0.82	0.83	0.87	0.88
Shared control	0.91	0.89	0.85	0.72	0.76
Student negotiation	0.89	0.89	0.91	0.87	0.81
Overall instrument	–	–	0.88	0.93	0.94
N	494	1600	290	110	354

[a]13-year-old science students (Taylor et al., 1995).
[b]High school science students (Taylor et al., 1997).
[c]290 elementary, middle and high school inservice and preservice teachers.
[d]110 upper elementary, middle and high school students.
[e]354 upper elementary, middle and high school students.

the major focus of the first year of the study was to assess the effectiveness of the protocols and instruments used. That effort included the investigation of the validity and reliability of the CLES that is reported in this article. Because previous reported analyses of the CLES had used the student version, the present analysis was conducted using the teacher version.

3.1. *Participants*

A relatively small number of inservice and preservice science teachers, only eleven the first year and no more than a few dozen over the course of four years, are participating in the TRN study. In order to assess the validity and reliability of the CLES 1(30), however, more teachers were needed. TRN researchers administered the CLES to 290 elementary, middle, and high school inservice and preservice science teachers, most of whom did not participate in the larger TRN study. Participants recorded their responses on computer-scorable answer sheets. Participants were also asked to record, directly on the survey, comments about items that they felt were difficult to understand.

3.2. *Data Analysis*

Once the data were screened and prepared, several analyses were conducted. The first was an exploratory factor analysis (EFA), used in the present study to analyze the relationships between items. Principal axis factoring (PAF) and oblimin rotation were used. These methods were selected because there was an underlying theoretical factor structure (five scales) and because it was also assumed that the scales might be related in a larger factor, namely, classroom learning environment (Tabachnick & Fidell, 1996, p. 666). Items with missing responses had the item mean substituted. Because five scales were hypothesized, the analysis was constrained to five factors. An examination of items that loaded strongly on each factor was then made to see if the items actually fit together.

Second, internal consistency of the CLES as a whole and of items within each scale was also investigated by determining the alpha reliability coefficient. Third, written comments from respondents were read and considered. Items which participants felt were confusing or overly redundant were noted. Informal comments from teachers after survey administration and during interviews were also considered.

4. Results

4.1. *Factor and Reliability Analyses for Teacher Sample*

An examination of the factor loadings (see Table III) was made. Loadings of less than 0.30, a commonly used cut-off, were eliminated. Most items loaded strongly on their hypothesized scale. There were exceptions, however. Item 6 (Personal Relevance scale: "What students learn has nothing to do with their out-of-school life."), the only negatively worded item in the CLES, had a much lower factor loading (0.30) than did other items in that scale. Item 7 (Uncertainty scale: "Students learn that science cannot provide perfect answers to problems.") similarly had a low factor loading (0.36). Item 18, (Critical Voice scale: "It's OK for students to speak up for their rights.") had similar factor loadings on both its own scale (0.41) and on the Uncertainty scale (0.42). Items 22 ("Students have a say in deciding how much time they spend on an activity.") and 24 ("Students help me to assess their learning."), both in the Shared Control scale, had lower loadings (0.43 and 0.38) than did the other items in that scale. (See Appendix A for a listing of all CLES items.)

Alpha reliability coefficients for the five scales were also examined (see Table II). While all of the coefficients were high enough to be considered adequate, there were items that did not contribute as much as others did to the overall scale reliability. Analysis revealed that eliminating Item 2 ("New learning starts with problems about the world outside of school.") and Item 6 from the Personal Relevance scale would lead to a higher alpha coefficient for that scale. Similarly, eliminating Item 7 from the Uncertainty scale,

TABLE III

Factor Loadings from Exploratory Factor Analysis (EFA)

Item	Factor loading				
	PR	UN	CV	SC	SN
1	0.73				
2	0.56				
3	0.65				
4	0.62				
5	0.66				
6	0.30				
7		0.36			
8		0.62			
9		0.67			
10		0.64			
11		0.61			
12		0.67			
13			0.65		
14			0.82		
15			0.75		
16			0.77		
17			0.55		
18		0.42	0.41		
19				0.87	
20				0.73	
21				0.79	
22				0.43	
23				0.78	
24				0.38	
25					0.65
26					0.81
27					0.81
28					0.77
29					0.73
30					0.86

Note. PR = Personal Relevance; UN = Uncertainty; CV = Critical Voice; SC = Shared Control; SN = Student Negotiation.

Item 18 from the Critical Voice scale, Items 22 and 24 from the Shared Control scale, and Item 25 ("Students get the chance to talk to other students.") from the Student Negotiation scale would increase those alpha coefficients.

4.2. *Revision of CLES*

Relatively few participants chose to write comments on the survey forms. A review of those comments, however, as well as conversations with some of the participating teachers, revealed two common comments. First, many participants felt there was too much redundancy. Some participants questioned, and in some cases complained strongly about, the need for six items asking essentially the same thing. Second, some of the items were confusing. The items mentioned above as problems identified by the factor analysis and the internal reliability analyses were also most frequently identified as confusing by participants.

The results were presented to the TRN team at a meeting following the end of the academic year. Discussions revealed a consensus that the CLES provided valuable information but that, for use with teachers, it needed to be revised to reduce redundancy and eliminate confusing items. A decision was made to keep the five scales but to reduce the number of items in each to four. In the process, the single negatively-worded item was eliminated. Small groups of TRN members were each given one scale to revise.

For each scale, items were examined to see if there were four different aspects of the scale construct that were addressed. Using information from the factor analysis and the internal consistency analysis, as well as a description of the scale, items that were redundant or confusing were eliminated or rewritten.

The result was a revised, more parsimonious form of the CLES (see Appendix B) containing 20 items, with four each in five scales. Terms that were found to be confusing were eliminated, as was the instrument's only negatively-worded item. Some items were also rewritten to ensure that different aspects of each scale's construct were addressed.

The revised CLES is being used in subsequent years of the TRN study. Internal consistency reliability results from the second and third years of the research can be seen in Table II. These results are for a student sample rather than for the teacher form of the CLES. The small number of teachers participating in the study precluded such a reliability analysis using the teacher form. The results indicated good internal consistency for the student form, with the same item and scale structure as is found in the teacher form.

5. Discussion

The CLES 2(20)[2] is being used in subsequent years of the study. Participating teachers and their students complete the questionnaire, thus allowing for comparisons between student and teacher perceptions. In addition, each participating teacher is interviewed and is observed teaching two different science lessons. The researcher then writes a profile of each teacher. The CLES 2(20) contributes to the profile, with each CLES scale being taken into account in a specific section of the profile. Personal Relevance and Uncertainty scales inform the Knowledge of Content section, Critical Voice informs Knowledge of Students, Shared Control informs Knowledge of Pedagogy, and Student Negotiation informs both Knowledge of Pedagogy and Knowledge of Students (Davis et al., 2002). Profiles from all teachers at each level (i.e. high school science teachers or middle school science teachers) are compiled to produce an overall summary.

To interpret the CLES 2(20) data, those researchers writing a teacher profile receive graphs showing how the teacher's perceptions compare with those of his or her students for each scale. For example, Lars Larson, a Grade 7 science teacher, has perceptions of his classroom environment that fit with those of his students for some scales, but which are rather different for other scales. Figure 1 shows the Personal Relevance scale. Lars sees the relevance of the content in his classroom as being fairly high ($M = 3.75$) on a scale ranging from 1 to 5. His students for the most part agree with him. The students' mean ($M = 3.81$) is essentially the same as their teacher's and the variation is not great.

For the Critical Voice scale, however, the views of Lars and of his stu-

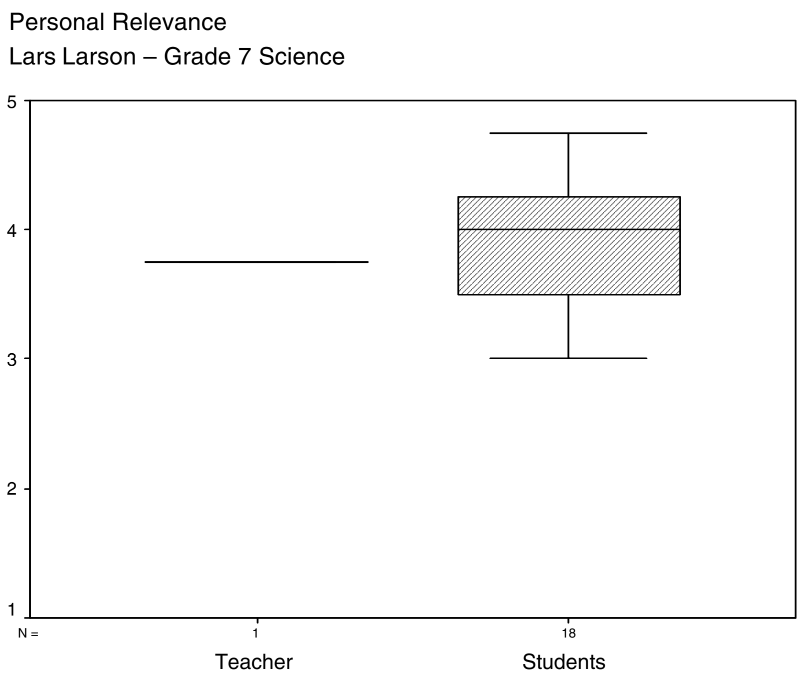

Figure 1. Example of a boxplot showing a circumstance in which the teacher and his students view a component of classroom learning environment similarly.

dents differ substantially. The teacher views his classroom as having a high degree of Critical Voice (*M* = 4.75). His students (Figure 2) have a lower mean (*M* = 3.80) and a wide range of views. Clearly, most students do not feel as free about questioning the teacher's plans and pedagogy as the teacher thinks that they do.

Another way to look at these data is to compare classrooms. Figure 3 shows how this class compares with other middle school science classes for the Personal Relevance scale. Three of the other teachers rated it higher in their classrooms than Lars did in his and, in those cases, the students' scores were not too far below the teacher's. In one case (Teacher E), though, the students emphatically disagreed with the teacher, rating Personal Relevance as very low.

Perceptions of classroom environment can be useful in a variety of ways. Sharing results with teachers can provide them with a student perspective that, for some teachers, is hard to get. Teachers' perceptions of classroom environment are often more positive than are those of their students. In some cases, the difference is dramatic, and having that information can provide a teacher with an impetus for change. Of course, a teacher can also

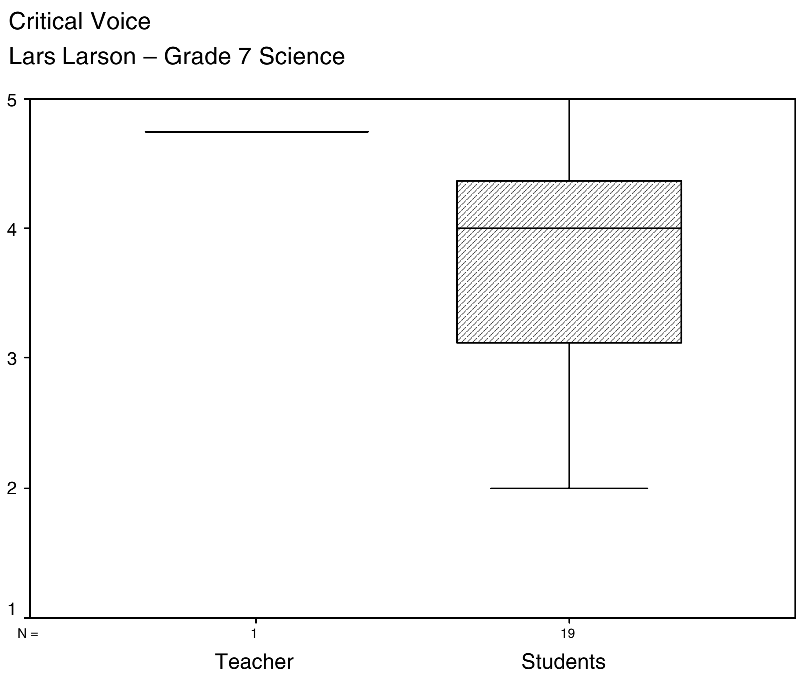

Figure 2. Example of a boxplot showing a circumstance in which the teacher and his students view a component of classroom learning environment differently.

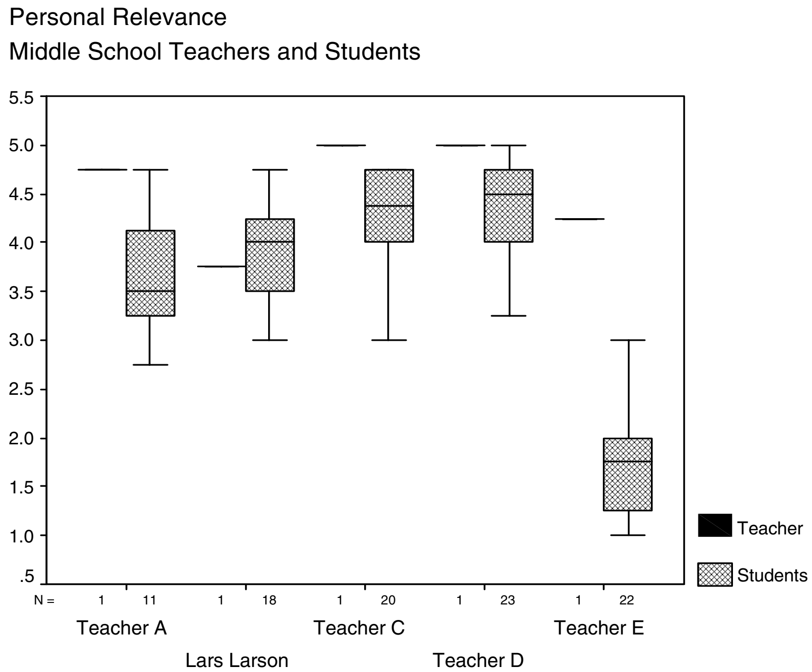

Figure 3. Example of a boxplot showing a comparison of the perceptions of five teachers and their students in regard to one component of classroom learning environment.

select an area of special interest to him or her. For instance, a teacher might not be concerned about whether or not students feel that they have a critical voice, but he or she might be deeply concerned that students see what they are doing as having personal relevance. That could be an area upon which to concentrate efforts and to check again later for improvement.

In the TRN study, the CLES 2(20) provides important teacher and student perspectives that contribute to profiles of the teachers and their classrooms, giving science teacher educators a better understanding of how their graduates are teaching. That understanding is further enhanced by the longitudinal nature of the study. Some of the participating teachers have been involved for up to three years, allowing an examination of how classroom learning environments change through the first years of beginning science teachers' careers.

The revised CLES 2(20) can provide valuable information about teachers' and students' perceptions of their classroom learning environments. The instrument is relatively easy to administer without requiring large amounts of valuable classroom learning time. It is most useful, of course, when it is used in conjunction with teacher interviews and classroom observations.

NOTES

1. The Teacher Research Network is led by TRN co-directors George Davis, Minnesota State University Moorhead, and Patricia R. Simpson, St Cloud State University. Cyndy Crist is the SciMath[MN] higher education project director.
2. After completion of the revisions, a paper summarizing the results was sent to Peter Taylor, one of the original authors of the CLES. He reported that he has also developed a revised version. Rather than being validated on science teachers, his questionnaire was used with science students. He also kept the same five scales, eliminated the sole negative item, and rephrased other items. He kept five items per scale. He named his revised version the CLES 2(25), indicating that it was the second version and had 25 items. He suggested that we call our version the CLES 2(20) (P. Taylor, personal communication, November 27, 2000).

APPENDIX A

CONSTRUCTIVIST LEARNING ENVIRONMENT SURVEY – CLES 1(30)

What Happens in My Science Classroom – Teacher Form

Response choices for all items are:

A Almost Always
B Often
C Sometimes
D Seldom
E Almost Never

Learning About the World (Personal Relevance)
In this class . . .

1. Students learn about the world outside of school.
2. New learning starts with problems about the world outside of school.
3. Students learn how science can be a part of their out-of-school life.
4. Students get a better understanding of the world outside of school.
5. Students learn interesting things about the world outside of school.
6. What students learn has nothing to do with their out-of-school life.

Learning about Science (Uncertainty)
In this class . . .

7. Students learn that science cannot provide perfect answers to problems.
8. Students learn that science has changed over time.
9. Students learn that science is influenced by people’s values and opinions.
10. Students learn that different sciences are used by people in other cultures.
11. Students learn that modern science is different from the science of long ago.
12. Students learn that science is about inventing theories.

Learning to Speak Out (Critical Voice)
In this class . . .

13. It's OK for students to ask me "Why do we have to learn this?"
14. It's OK for students to question the way they are being taught.
15. It's OK for students to complain about activities that are confusing.
16. It's OK for students to complain about anything that stops them from learning.
17. It's OK for students to express their opinion.
18. It's OK for students to speak up for their rights.

Learning to Learn (Shared Control)
In this class . . .

19. Students help me to plan what they are going to learn.
20. Students help me to decide how well they are learning.
21. Students help me to decide which activities are best for them.
22. Students have a say in deciding how much time they spend on an activity.
23. Students help me to decide which activities they do.
24. Students help me to assess their learning.

Learning to Communicate (Student Negotiation)
In this class . . .

25. Students get the chance to talk to other students.
26. Students talk with other students about how to solve problems.
27. Students explain their ideas to other students.
28. Students ask other students to explain their ideas.
29. Students are asked by others to explain their ideas.
30. Students explain their ideas to each other.

APPENDIX B

CONSTRUCTIVIST LEARNING ENVIRONMENT SURVEY CLES 2(20)

What Happens in My Science Classroom – Teacher Form

Response choices for all items are:

A Almost Always
B Often
C Sometimes
D Seldom
E Almost Never

Learning About the World (Personal Relevance)
In this class . . .

1. Students learn about the world inside and outside of school.
2. New learning relates to experiences or questions about the world inside and outside of school.

3. Students learn how science is a part of their inside- and outside-of-school lives.
4. Students learn interesting things about the world inside and outside of school.

Learning About Science (Uncertainty)
In this class . . .

5. Students learn that science cannot always provide answers to problems.
6. Students learn that scientific explanations have changed over time.
7. Students learn that science is influenced by people's cultural values and opinions.
8. Students learn that science is a way to raise questions and seek answers.

Learning to Speak Out (Critical Voice)
In this class . . .

9. Students feel safe questioning what or how they are being taught.
10. I feel students learn better when they are allowed to question what or how they are being taught.
11. It's acceptable for students to ask for clarification about activities that are confusing.
12. It's acceptable for students to express concern about anything that gets in the way of their learning.

Learning to Learn (Shared Control)
In this class . . .

13. Students help me plan what they are going to learn.
14. Students help me to decide how well they are learning.
15. Students help me to decide which activities work best for them.
16. Students let me know if they need more/less time to complete an activity.

Learning to Communicate (Student Negotiation)
In this class . . .

17. Students talk with other students about how to solve problems.
18. Students explain their ideas to other students.
19. Students ask other students to explain their ideas.
20. Students are asked by others to explain their ideas.

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