Learning Environments in Our Science Classrooms: The View of International Students

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Abstract

The Constructivist Learning Environment Survey (CLS) has been developed for researchers who are interested in constructivist reform of high school science and mathematics. This study uses the CLS to understand international students' perceptions of the learning environments in university science courses. The results of the study, which combined statistical analyses and interpretive inquiry, confirmed the practical viability of the survey and generated important insights into the use of learning environment questionnaires in classrooms; perspectives on how science professors and instructors can be enabled to reflect on student's prior knowledge; developing individual's as autonomous learners, and negotiating students own understandings with other students.

KEY WORDS: constructivism, international perspective, learning environment

Introduction

Over the past few decades, schools around the world have received criticism from various educational research organizations regarding student achievement. Studies would indicate that even students' who score well on standardized tests often are unable to integrate successfully memorized facts with real-life applications outside the school (Yager 1991). Resnick (1987) has commented that practical knowledge and school knowledge is becoming mutually exclusive; many students see little connection between what they learn in the classroom and real life; and, Project 2061 (1989) charges that "the present curricula in science and mathematics are overstuffed and undernourished."

The implication is that current curricula emphasize the learning of answers more than the exploration of questions; memory at the expense of critical thought; memorizing bits and pieces of information instead of understanding in context; recitation over argument; and, reading in lieu of doing. As well, teachers fail to "encourage students to work together, share ideas and information freely with one another or use modern instruments to extend their intellectual capabilities" (Resnick, 1987). Even though much of this criticism has been levied on U.S. public schools, countries around the world face the same dilemma. And as more international students come to the U.S. to study at colleges and universities, they face similar situations in college science classrooms shared by their U.S. peers. One proposed solution for this problem is to prepare students to become adaptive learners. That is, students should be able to apply what they learn in school to the various and unpredictable situations they might encounter over the course of their daily lives. To accomplish this, there must be a change in the focus of the classroom from teacher-centred to student-centred using a constructivist approach.

Constructivism

Constructivism is not a new concept. It has its roots in philosophy and has been applied to sociology and anthropology, as well as cognitive psychology and education. Giambatista Vico, perhaps the first constructivist philosopher, commented in 1710 that "...[a] person only knows something if a person can explain it" (Yager 1991). Immanuel Kant further elaborated on this idea by asserting humans are not passive recipients of information. Instead, Kant suggested learners actively take knowledge, connect it to previously assimilated knowledge, and make it their own by constructing their own interpretation (Cheek, 1992).

Constructivism, at least as it appears in science and mathematics education, has contributed to several significant intellectual movements and has its origins in the Piagetian-led cognitive rebellion against behaviourist theories of learning. A renowned psychologist, Piaget understood that his research—the development of genetic epistemology— made a significant contribution to western philosophical traditions. Piaget's theory of mind, and his separation of the unknowable deep phenomena from the knowable phenomena, is an important element for constructivists, particularly personal constructivists such as Ernst von Glasersfeld.

Constructivism has also been shaped by the widespread insurrection against positivist theories of science. This revolt began in Europe in the 1930's and spread to Anglo-American world in the 1960's with the publication of Kuhn's "The Structure of Scientific Revolutions." Subsequently most of the cherished tenets of positivism-the possibility of impartial knowledge freed from theoretical assumptions; the uniqueness of science as a way of knowing; the inductivist view of theory development; and, the goal of having the mind be a mirror of nature-have been severely criticized and refuted. (Zahorik, 1995)

In some instances, postpositivist as well as postmodernist views about science have influenced constructivism. After all, many if not most of the postpositivists held to modernist views of science; they wanted knowledge of the world and they thought that science could deliver such knowledge. They just denied that positivism gave an adequate account of the processes and outcomes of the scientific endeavour. More recently the works of Foucault, Derrida, and other postmodernists have challenged such assumptions. Foucault (Fendler, 1998) suggests that the development of scientific knowledge has more to do with the changing patterns of power in society than with testing and validation of theories. Some constructivists explicitly or implicitly have adopted such postmodernist orientations to knowledge. This is apparent when individuals show that the development of knowledge systems is purely an instrumentalist matter. The purpose of which is to serve individual interests and purposes. There have been other intellectual traditions that have contributed to the contemporary heterogeneous constructivist doctrine: the personal-construct psychology of Kelly (Gaines, 1993) has been used, and of special significance for social constructivists has been the theory of language acquisition originally developed by Vygotsky in Russia in the 1930's. One recent review has identified at least the following varieties: contextual, dialectical, empirical, information-processing, methodological, moderate, Piagetian, post epistemological, pragmatic, radical, realist, social, and socio-historical (Good, Wandersee & St Julien, 1993).

Learning Environment

What happens in a learning environment and what has happened in the lives of the learner to shape their expectations with respect to learning science? Clearly, individuals bring to the classroom beliefs and perceptions about classroom roles for themselves, peers and teachers (Thomas & Pedersen, 2001). These beliefs not only govern how an individual acts in specific situations, but also can constrain the meanings and actions of others. Learning environment research is primarily focused on students' perceptions of the learning environment. In their overview of research on learning environments, Fraser (1994) concluded that student perceptions account for appreciable amounts of variance in learning outcomes, often beyond that attributable to background student characteristics. The practical implication from this research is that "student outcomes might be improved by creating classroom environments found empirically to be conducive to learning" (Fraser, 1994, p. 27). Student perceptions of the learning environment influence learning behaviors and outcomes that in turn become part of the experienced learning environment of self and others.

Purpose

The purpose of this article is to examine international students' perceptions of the constructivist-learning environment in university science courses. The goal is to provide teachers with an efficient means of learning more about their students' perceptions of the classroom-learning environment. With this information, teachers will be better prepared and enabled to reflect on student's prior knowledge, develop individuals as autonomous learners, and negotiate their own understandings with other students.

Many theorists provide key dimensions regarding the characteristics of teacher behaviours for constructivist teaching. To gain an understanding of the perceptions of international students, this study set out to use an instrument based on these aforementioned dimensions. The instrument, the Constructivist Learning Survey (CLS) (Johnson & McClure, 2000) was used to determine if international students perceived that constructivist teaching methodologies were being used in undergraduate and/or graduate science courses they were enrolled in. The dependent variables for this research is the perception of international students, coming from traditional education systems, regarding their science teacher's behaviours, and how their teachers' teaching methods are related to constructivist learning theory. Independent variables include: teacher behaviour, student-teacher interactions, student-student interactions, and technology.

Significance of Problem

There are many studies relating to constructivist learning theory. However, there are few studies that focus on international science students who come from traditional education systems and their perceptions of constructivist learning environments. The implications of this study will benefit teachers at all levels since the study has as a focus a cultural perspective concerning the teaching of science courses.

Methodology

A quantitative (ex post facto) and qualitative research approach was used. The survey was used in an exploratory nature to examine students' perceptions of science courses at the university/-college level (biology physics, and chemistry). An additional intent was to assess the validity of the CLS for use in college science courses. Samples of convenience from biology, chemistry, and physics departments at a major southwestern university were used. Sixteen people, eight undergraduate students and eight graduate students, were selected from the sample of convenience during the spring semester 2003. Students in the sample represent six different countries—South Korea, China, Turkey, Taiwan, Russia, and Egypt. The gender and majors of these individuals are shown in Table 1.

Table 1

Reported number of Males and Females, and Science Courses Major

	Male	Female	Undergrad	Grad
Biology	4	6	6	4
Physics	2	2	2	2
Chemistry	2	—	—	2

Simple random sampling methodology was used in participation selection, stratified by departments or content affiliation. The College of Arts & Sciences web page was used to contact course instructors/teachers. Instructors were then asked about how many of their students were international, and permission was gained to communicate with them. Not all the students contacted were willing to take part in the study. Four physics students, ten biology students and two chemistry students agreed to participate and complete the CLS.

The purpose of the survey was to ask students to describe the important aspects of their current science classroom. The CLS is concerned with the extent of the emphasis within a classroom learning environment on: (a) making science and mathematics seem relevant to the world outside school; (b) engaging students in reflective negotiations with each other; (c) teachers inviting students to share control of the design, management, and evaluation of their learning; (d) students being empowered to express concern about the quality of teaching and learning activities; and (e) students experiencing the uncertain nature of scientific and mathematical knowledge. It was made clear to all participants that there were no right or wrong answers; that this was not a test; and the answers given would not affect final grades.

The CLS consists of two separate forms, a preferred form and a perceived form. Both versions solicit students' opinions regarding classroom environment and each form consists of five sections with six questions per section. Each scale of the Constructivist Learning Survey was designed to measure students' perceptions of the frequency of occurrence of five key dimensions of a constructivist-learning environment:

- **Personal Relevance** *(Learning about the world)* focuses on the connectedness of school science to students' out-of-school experiences, and on making use of students' everyday experiences as a meaningful context for the development of students' scientific knowledge.
- **Uncertainty** *(Learning about science)* involves the extent to which opportunities are provided for students to experience scientific knowledge as arising from theory-dependent inquiry involving human experience and values, and as evolving, non-foundational, and culturally and socially determined.
- **Critical Voice** *(Learning to speak out)* involves the extent to which a social climate has been established in which students feel that it is legitimate and beneficial to question the teacher's pedagogical plans and methods, and to express concerns about any impediments to their learning.
- **Shared Control** *(Learning to learn)* is concerned with students being invited to share with the teacher control of the learning environment, including the articulation of learning goals, the design and management of learning activities, and the determination and application of assessment criteria.
- **Student Negotiation** *(Learning to communicate)* assesses the extent to which opportunities exist for students to explain and justify to other students their new ideas, to listen attentively and reflect on the viability of other students' ideas and, subsequently, to reflect self-critically on the viability of their own ideas.

(**Note:** All scale descriptions are from: Taylor, et al., 1995)

The response alternatives for each item on both forms were Likert type—Almost Always (5 points), Often (4 points), Sometimes (3 points), Seldom (2 points), and Almost Never (1 points) (see Appendix A for both versions of the CLS). Each version of the survey was administered to each of the science students during the same week and took about 20 minutes to complete. In a follow-up interview to the CLS, the participants were asked, "What is the difference between your countries education system and the system that you are currently enrolled?" The interviews averaged five minutes in length.

When classroom environment perceptions have been used as predictor variables, associations between student's cognitive and affective outcomes and the learning environment have been found. Fraser (1994) provides a broad overview of these results, which show that classroom environment perceptions can influence students' outcomes. In keeping with this previous research, associations between students' perceptions of their actual constructivist learning environments and their attitudes toward their science classes were investigated.

Results

A constructivist perspective on learning environments has been described as "an individual's socially mediated beliefs about the opportunities to learn and the extent to which the social and physical milieu constrains learning" (Lorsbach & Tobin, 1995, p. 20). The first step in the validation of the CLS involved a series of factor analysis whose purpose was to examine the internal structure of the set of 30 items. A principle components analysis was used to generate orthogonal factors. Since the instrument was designed with five scales, a five-factor solution was considered. Table 2 represents mean, standard deviation, and alpha correlations, for independent samples between preferred and perceived perceptions of classroom environment.

Table 2

Descriptive Statistics: Mean, Standard Deviation, and Alpha Correlation, for Independent Samples

Scale	Mean (Perc. - Pref.)	Standard D. (Perc. - Perf.)	Alpha Coefficient
Personal Relevance	21.2 - 28.6	4.2 - 5.8	.81 - .68
Student Negotiation	19.5 - 28.1	4.1 - 5,1	.83 - .69
Shared Control	20.5 - 26.9	5.5 - 5.8	.82 - .71
Critical Voice	12.9 - 29.2	3.3 - 5.6	.94 - .69
Uncertainty	18.3 - 27.5	4.2 - 4.6	.84 - .70

Maximum possible score = 30,
Minimum possible score = 6

The value of the standard deviations in Table 2 equals a fairly large proportion of range. These relatively large standard deviations on most of the mean scores suggest a lack of homogeneity among the perceptions of the students. Table 2 also shows that two of the scales have relatively low internal consistencies. Therefore, it appears that the CLS is appropriate for use in university/-college science courses; however, the apparent lack of internal inconsistency was a focus of subsequent investigations. Nonetheless, the results of the CLS would indicate students perceive that their science teachers' behavior closely represents the dimensions of a constructivist teacher. Still, we cannot say that the students' teachers are actually constructivist (See Figure 1).

Table 3 shows median scores for the Likert-scale data. Interestingly, students' median and mean perceived scores were lower in every section of the survey as compared to their preferred scores as indicated in Table 1 and Table 3.

Table 3

Median Scores Overall CLS Perceived and Preferred Scores

Scale	Median Scores Perceived	Preferred
Personal Relevance	20	28
Student Negotiation	19	29
Shared Control	20	26
Critical Voice	15	29
Uncertainty	18	28

This would show that the students preferred methods of being taught biology, chemistry, and physics did not occur in any of the science courses they were taking. From the interviews conducted, students agreed that in the constructivist-learning environment is "...[-constructivism] is a very useful [way] to learn for all international students." They also said that "-traditional learning has focused on the transmission of discrete pieces of information, and traditional curriculum often pays little attention to whether students use the information in any real-life context." One student indicated, "it [traditional teaching/curriculum] does not provide students with opportunities to develop the kinds of critical thinking skills and problem-solving abilities that are central to thinking and learning." Students agreed that the constructivist perspective gave them an opportunity to learn easily, and make the learning more permanent and meaningful.

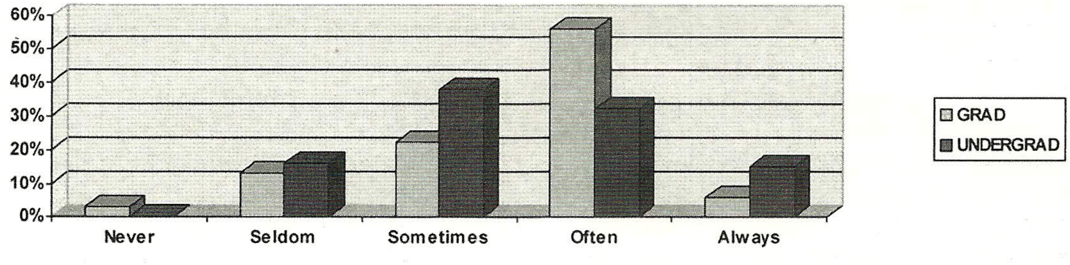

Figure 1. Section One Questionnaires About Teacher Behaviors

Conclusions

Constructivism is intimately connected with experience. Learners will reformulate his/her existing mental structures only if new information or experiences are connected to existing knowledge. Memorized facts or information that has not been connected with the learner's prior experiences will be quickly forgotten. In short, the learner must actively construct new information into his/her existing mental framework for meaningful learning to occur.

The outcomes of this research suggest that neither international graduate nor international undergraduate students' prior experiences (from prior classroom environments) have influenced current expectations for learning science. The current expectations that these international students' carry with them are similar to constructivist-learning environments which are in contrast to the learning environments experienced by these students. The results would also indicate that international students are not entirely satisfied with current learning environments. This suggests that university professors and instructors should be more aware of the expectations of all students for learning environments. More specifically, professors and instructors should strive to use constructivist learning theories and work towards creating learning environments that better meets students' expectations about science.

Teachers' should organize classroom information around concepts or conceptual clusters, questions and discrepant events to engage the students'. Professors and instructors should assist the students in developing new insights and make connections to prior learning experiences. Concepts in science classrooms should be presented holistically as broad concepts and then broken down into smaller parts using student centred explorations where students are encouraged to ask their own questions; carry out their own experiments; make their own analogies; and, come to their own conclusions. Accordingly, this approach takes the attention away from the professor/instructor and places it on the learners. The instructor becomes a facilitator and their prime role is to motivate and encourage the learners.

The implications of this are far reaching. Not only should professors and instructors at universities and colleges in the United States consider the perceptions of international students, but professors, teachers and instructors around the world should understand that students' in their classrooms have an orientation to constructivist-learning environments—a learning environment that should engage students in the construction of knowledge based on prior experiences through active exploration of science concepts.

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Appendix A

Directions

1. **Purpose of the Questionnaire**

   This questionnaire asks you to describe important aspects of the science classroom, which you are in right now. <u>There are no right or wrong answers.</u> This is not a test and your answers will not affect your assessment. <u>Your opinion is what is wanted.</u> Your answers will enable us to improve future science classes.

2. **How to Answer Each Question**

   On the next few pages you will find 30 sentences. For each sentence, circle only two numbers, one is for preferred and other is perceived, corresponding to your answer. You can draw circle and cross. For example:

		Almost Always	Often	Some-times	Seldom	Almost Never
8	The teacher asks me questions.	5	4	3	2	1

- If you think this teacher almost always asks you questions, circle or cross the 5.
- If you think this teacher almost never asks you questions, circle or cross the 1.
- Or you can choose the number 2, 3 or 4 if one of these seems like a more accurate answer.

Learning about the world	**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
In this class...					
1. I learn about the world outside of school.	1	2	3	4	5
2. My new learning starts with problems about the world outside of school.	1	2	3	4	5
3. I learn how science can be part of my out-of-school life.	1	2	3	4	5
4. I get a better understanding of the world outside of school.	1	2	3	4	5
5. I learn interesting things about the world outside of school.	1	2	3	4	5
6. What I learn has nothing to do with my out-of-school life.	1	2	3	4	5

Learning about science	**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
7. I learn that science cannot provide perfect answers to problems.	1	2	3	4	5
8. I learn that science has changed over time.	1	2	3	4	5
9. I learn that science is influenced by people's values and opinions.	1	2	3	4	5
10. I learn about the different sciences used by people in other cultures.	1	2	3	4	5
11. I learn that modern science is different from the science of long ago.	1	2	3	4	5
12. I learn that science is about creating theories.	1	2	3	4	5

Learning to speak out	**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
13. It's OK for me to ask the teacher 'Why do I have to learn this?'	1	2	3	4	5
14. It's OK for me to question the way I'm being taught.	1	2	3	4	5
15. It's OK for me to complain about teaching activities that are confusing.	1	2	3	4	5
16. It's OK for me to complain about anything that prevents me from learning.	1	2	3	4	5
17. It's OK for me to express my opinion.	1	2	3	4	5
18. It's OK for me to speak up for my rights.	1	2	3	4	5

Learning to learn	Almost Never	Seldom	Some-times	Often	Almost Always
19. I help the teacher to plan what I'm going to learn.	1	2	3	4	5
20. I help the teacher to decide how well I am learning.	1	2	3	4	5
21. I help the teacher to decide which activities are best for me.	1	2	3	4	5
22. I help the teacher to decide how much time I spend on learning activities.	1	2	3	4	5
23. I help the teacher to decide which activities I do.	1	2	3	4	5
24. I help the teacher to assess my learning.	1	2	3	4	5
Learning to communicate	**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
25. I get the chance to talk to other students. solve problems.	1	2	3	4	5
26. I talk with other students about how to	1	2	3	4	5
27. I explain my understandings to other students.	1	2	3	4	5
28. I ask other students to explain their thoughts.	1	2	3	4	5
29. Other students ask me to explain my ideas.	1	2	3	4	5
30. Other students explain their ideas to me.	1	2	3	4	5