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ABSTRACT

This paper reports on research conducted to determine whether science curriculum reform efforts in Korea have had a positive effect on the classroom learning environment from a constructivist point of view. The Constructivist Learning Environment Survey (CLES) was administered to 1083 students and 24 science teachers in 12 different schools. One class of grade 10 students and one class of grade 11 students were sampled at each school. Results indicate that grade 10 students held more positive perceptions of their learning environment in a general science class, which was designed so that students would learn about and understand basic science concepts through inquiry and negotiation, than did grade 11 students who studied an academic-centered science curriculum. Three other achievements were reported: a Korean-language version of the CLES was developed and found to be reliable and valid; there were statistically significant relationships between classroom environment and student attitudes; and there were differences between student perceptions of actual and preferred environment in that students tended to prefer a more positive environment than what was perceived to be present. Contains 36 references. (WRM)

Constructivist Learning Environments in Science Classes in Korea

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INTRODUCTION

The constructivist view of learning has made a major impact on science education, particularly during the past decade (Treagust, Duit, & Fraser, 1996). The implications for a science curriculum centred on a constructivist philosophy were identified initially in a number of research studies which focused on students' concept learning in science (Driver & Oldham, 1986; Pines & West, 1986; Posner, Strike, Hewson, & Gertoz, 1982). The constructivist view of learning has had a most noticeable influence on curriculum thinking in science since 1980 (Wubbels & Brekelmans, 1997).

A constructivist approach to learning is based on the idea that the learner constructs his or her own knowledge through negotiation of meaning (Hand, Treagust, & Vance, 1997). Tobin and Tippins (1993) suggested that constructivism has been used as a referent for building a classroom that maximises student learning. In such a classroom, the teacher takes account of what students know, maximises social interactions between learners so that they can negotiate meaning, and provides a variety of sensory experiences from which learning is built. Duit and Confrey (1996) noted the following five assumptions shared by mathematics and science educators for reorganising the curriculum and teaching to improve learning in school science and mathematics from a constructivist perspective: first, more emphasis is usually given to the applicability of science and mathematics knowledge in situations in which students are interested; second, introduction into the curriculum of issues of meta-knowledge about science and mathematics is needed; third, extinguishing students' everyday conceptions is impossible and inadvisable; fourth, constructivist approaches are student-centred; and, fifth, the norms and patterns of classroom interaction are a fundamental influence on the effectiveness of reform efforts. They also suggested that innovation processes could be implemented in terms of developing new media, including science textbooks, revising traditional content structures, and using a range of constructivist teaching strategies.

Science education in Korea has been directed towards producing academic, professional scientists over the past 20 years, even though the main aims of science education at the primary, middle and high school are assumed to help students to become healthy and creative members of society with some necessary scientific literacy. Constructivist approaches have been reflected in the science curriculum and teachers' guide to this curriculum since 1982. However, conventional lecture-type class instruction and discipline-oriented approaches have remained dominant at the secondary level, particularly the senior secondary level, until recently. Furthermore, there has been a general concern that the relevance of everyday life situations has not been considered in science education (Han, 1995).

These criticisms were responded to in Korea's new sixth National Science Curriculum which tried to reduce the amount of content knowledge and give an added emphasis to students' problem solving in everyday contexts. This is particularly so in General Science which was introduced as a compulsory subject for all high school students and reflects the constructivist view. Students are expected to learn about and understand basic scientific concepts through student-centred activities and negotiation. The content is organised in a way that relates it to actual, concrete problems encountered by students in daily life. The intention is to facilitate the students' understanding of science knowledge and the process of scientific inquiry (Han, 1995). However, other science subjects, such as Physics, Chemistry, Biology, and Earth Science, have remained academically content oriented in Korea.

The aim of this study was to investigate the extent to which this new General Science at the senior secondary level had influenced the constructivist nature of grade 10 science classroom learning environments. As students in grade 11 had not been exposed to the new curriculum it could be expected that those grades were not as constructivist in nature as grade 10.

FIELD OF LEARNING ENVIRONMENT

Over the past two decades, considerable interest has been shown internationally in the conceptualisation, measurement, and investigation of perceptions of psychosocial characteristics of the learning environment of primary and secondary schools (Taylor, Fraser,

& Fisher, 1997). Results of research studies in this area have been reviewed in several books (e.g., Fraser, 1986; Fraser & Walberg, 1991) and reviews (e.g., Fraser, 1991, 1994, 1998).

Several instruments have been developed to assess classroom environment. The *Learning Environment Inventory* (Fraser, Anderson, & Walberg, 1982), the *Classroom Environment Scale* (Moos & Trickett, 1974; Trickett & Moos, 1973) and the *Individualised Classroom Environment Questionnaire* (Rentoul & Fraser, 1979) have been used extensively to assess classroom environment at the secondary level. The *My Class Inventory* (Fisher & Fraser, 1981; Fraser, Anderson, & Walberg, 1982) and the *College and University Classroom Environment Inventory* (Fraser & Treagust, 1986) were developed for use at the primary and tertiary levels, respectively. Because of the importance and uniqueness of laboratory settings in science education, the *Science Laboratory Environment Inventory* was developed to assess the environment of science laboratory classes (Fraser, Giddings, & McRobbie, 1995). Also in order to provide a questionnaire for the study of the science outdoor learning environment, the *Science Outdoor Learning Environment Inventory* was recently developed (Orion, Hofstein, Tamir, & Giddings, 1997).

Although most classroom environment research has focused on the assessment and improvement of learning and teaching, it has done so largely within the context of traditional epistemology underpinning the established classroom environment (Taylor, Fraser & Fisher, 1997). However, the traditional teacher-centred, didactic approach to teaching has been extensively criticised and there is a better understanding of the nature of knowledge development. Therefore, 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). Originally, the CLES was found to be valid (Taylor & Fraser, 1991; Taylor, Fraser & Fisher, 1997) and to contribute insightful understanding of classroom learning environment (Roth & Roychoudury, 1993; 1994).

But Taylor, Fraser & White (1994) found major socio-cultural constraints to the development of constructivist learning environment and developed a new version of the CLES based on critical constructivism, which combines key elements of the radical constructivist theory of von Glasersfeld (1993) and the critical social theory of Habermas (1978). The new CLES is composed of the five scales of Personal Relevance, Uncertainty, Critical Voice, Shared Control, and Student Negotiation, which recognise that the cognitive constructivist activity of the individual learner occurs within, and is constructed by, a socio-cultural context (Taylor, Dawson, & Fraser, 1995). Table 1 presents a description and a sample item of each of the scales of the CLES.

Table 1
Description of Scales and Sample Items for the CLES

Scale	Description	Sample Item
Personal Relevance	Relevance of learning to students' lives	In this science class I learn about the world outside the school.
Uncertainty	Provisional status of scientific knowledge	I learn that the views of science have changed over time.
Critical Voice	Legitimacy of expressing a critical opinion	It's OK to ask the teacher, "Why do we have to do 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 ideas.

Following small-scale qualitative studies, the new CLES was found to be valid and reliable in its statistical characteristics through two large-scale quantitative surveys of classroom learning environments in Australia (Taylor, Dawson, & Fraser, 1995) and in the USA (Dryden & Fraser, 1998). However, as the CLES had never been used in Korea, an essential part of this study was to provide cross-validation data on the use of the CLES in Korea.

Two forms of the CLES have been developed to gather students' perceptions of science classrooms. These forms are named the Student Actual and Student Preferred (Taylor, Dawson, & Fraser, 1995). Although item wording is almost identical in the actual and preferred forms, words such as "I wish" are included in the preferred form to remind students that they are rating their preferred, or ideal classroom, rather than the actual classroom environment. For example, the statement, "In this class, I learn about the world outside of school" in the actual form of the CLES is changed in the preferred form to, " In this class, I wish that I learned about the world outside of school". It was decided to investigate differences between students' perceptions of their actual and preferred constructivist learning environments in this study.

When classroom environment perceptions have been used as predictor variables, associations between student cognitive and affective outcomes and learning environment have been found. Fraser (1994) provides a broad overview of these results which indicate 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 class were investigated in this study.

The CLES was selected to investigate the extent to which the new General Science at the senior secondary level had indeed influenced the constructivist nature of classroom learning environments in grade 10 science in Korea. However, before this could be done, the English language versions of the four forms of the CLES were translated into Korean by one of the researchers. A back translation of the Korean version into English, by people not involved in the original translation, was then completed. At this stage, it was verified that each statement retained its original meaning.

Thus, the objectives of this study were to investigate: first, whether the Korean version of the CLES is valid and reliable; secondly, differences in students' perceptions of their actual and preferred constructivist learning environment; thirdly, whether grade 10 students' perceptions of the learning environment of general science classes were more constructivist-oriented than those of grade 11 students; and finally, associations between students' perception of the constructivist learning environment and their attitude to science.

METHOD

The CLES was administered to 1083 students and 24 science teachers in 12 different schools, four of which were located in the metropolitan area, four in a small-sized city, and four in the rural area of Korea. One class of grade 10 students and one class of grade 11 students were sampled at each school. The number of boys and girls were almost the same in each local area, and in each grade. The questionnaires were sent by mail, or delivered personally, with information about the instruments and guidelines for administration.

Each student in the sample responded to the actual and preferred versions of the CLES and to a seven-item 'Attitude to This Class' scale which was based on the *Test of Science Related Attitudes* (Fraser, 1981). The data were analysed to check the *a priori* factor structure of the CLES, internal consistency of each of the scales, discriminant validity, and ability to differentiate between classrooms. MANOVA was used to determine whether there were differences in the means of the five scales of actual and preferred versions between grade 10 students and grade 11 students. Educational significance of differences between grades was assessed by calculating the effect sizes (the difference between two means divided by the pooled standard deviation). In this process, an effect size of .2 was considered very low, .5 medium, .7 high, and .8 very high (Cohen, 1977). Simple and multiple correlation data were used to determine whether there were any associations between students' perceptions of their constructivist learning environments and their attitude to class.

RESULTS AND DISCUSSION

Validation of the CLES

The first step in the validation of the CLES involved a series of factor analyses whose purpose was to examine the internal structure of the set of 30 items. A principal components analysis with varimax rotation was used to generate orthogonal factors. Since the instrument was designed with five scales, a five-factor solution was considered. Table 2 shows the factor loadings obtained for the sample of 1,083 school students in 24 classes in 12 schools. The factor analyses, depicted in Table 2, support the 30-item five-scale version of the CLES in both its actual and preferred forms. The only factor loadings included in this table are those greater than or equal to the conventionally accepted value of 0.30. Thus, the results depicted in Table 2 confirm strongly the *a priori* factor structure of the Korean version of the CLES.

Table 2
Factor loadings for Actual and Preferred forms of the CLES

Item No.	Factor Loading									
	Personal Relevance		Uncertainty		Critical Voice		Shared Control		Student Negotiation	
	Actual	Prefer	Actual	Prefer	Actual	Prefer	Actual	Prefer	Actual	Prefer
1	.76	.79								
2	.70	.77								
3	.59	.68								
4	.75	.78								
5	.73	.73								
6	.47	-								
7			-	.33						
8			-	.74						
9			-	.67						
10			.60	.63						
11			.73	.75						
12			.77	.59						
13					.67	.73				
14					.71	.74				
15					.77	.81				
16					.71	.80				
17					.72	.69				
18					.79	.73				
19							.70	.66		
20							.75	.78		
21							.74	.77		
22							.77	.79		
23							.73	.80		
24							.58	.70		
25									.69	.67
26									.78	.74
27									.79	.78
28									.78	.80
29									.73	.76
30									.75	.76

Loadings smaller than .3 omitted.

Table 3 reports validation information for both actual and preferred forms of the CLES based on its use in Korea. The alpha reliability coefficient was used as the index of scale internal consistency, while the mean correlation of a scale with the other four scales was used as a convenient index of scale discriminant validity. With the individual student as the unit of analysis, the alpha reliability ranged from .64 to .87 for the actual form and from .79 to 91 for the preferred form. This suggests that all scales of the Korean version of the CLES possess satisfactory internal consistency. It is noteworthy that the value range in this study, and the fact that the Uncertain scale has the lowest reliability, is almost the same as those reported by Taylor, Fraser, & Fisher (1997).

Another feature considered important in a classroom environment instrument is the discriminant validity of each scale of the instrument, that is, the extent to which the scale measures a dimension different from that measured by any other scale. In this study, the mean correlations of one scale with the other four scales ranged from .24 to .38 for the actual form and from .44 to .50 for the preferred form. These values can be regarded as small enough to confirm the discriminant validity of the CLES, indicating that each scale measures distinct, although somewhat overlapping, aspects of the classroom environment.

Table 3
Internal Consistency (Cronbach alpha coefficient), Discriminant Validity (Mean Correlation with other Scales) and Ability to Differentiate between Classrooms for the CLES

Scale	Version	Alpha Reliability	Mean Correlation with Other Scales	ANOVA Results (eta^2)
Personal Relevance	Actual	0.79	0.30	0.07**
	Preferred	0.85	0.48	
Uncertainty	Actual	0.64	0.26	0.06**
	Preferred	0.79	0.47	
Critical Voice	Actual	0.84	0.24	0.05**
	Preferred	0.90	0.45	
Shared Control	Actual	0.86	0.38	0.07**
	Preferred	0.89	0.44	
Student Negotiation	Actual	0.87	0.33	0.13**
	Preferred	0.91	0.50	

** $p<0.01$

Another desirable characteristic of the actual form of any instrument like the CLES is that it is capable of differentiating between the perceptions of students in different classrooms. That is, students within the same class should perceive it relatively similarly, while mean within-class perceptions should vary from class to class. This characteristic was explored for each scale of the CLES using a one-way ANOVA, with class membership as the main effect. It was found that each CLES scale differentiated significantly ($p<.01$) between classes and that the eta^2 statistic, representing the proportion of variance explained by class membership, ranged from .05 to .13. These figures are relatively low and suggest that the learning environment of most science classes is quite similar in Korea. Most science teachers teach their students according to the textbooks which have a close relationship with the National Curriculum in Korea. Science textbooks published by private publishers must pass the screening procedures of the Evaluation Committee of Ministry of Education. The Evaluation Committee focuses on whether or not the drafts supplied meet the educational goals, objectives and specifications of the individual subjects as described in the National Curriculum (Han, 1995). Thus, most of the textbooks have similar content and structure. This might be one of the reasons for the existence of similar learning environments across science classes in Korea.

Differences between grades 10 and 11

In Korea, all grade 10 students have studied General Science since 1996, when it was newly introduced, with the sixth revision of the National Curriculum taking place in 1992. This subject places emphasis on students' using inquiry skills with problems which they encounter in their daily environment (Han, 1995). Textbooks developed for this subject reflect a constructivist-oriented view in which students are expected to learn about and understand basic scientific concepts through their active involvement in the inquiry process and negotiation in class or group discussion.

On the other hand, grade 11 students study one of four sciences such as physics, chemistry, biology, or earth science. The goals and objectives of these curricula also emphasise the constructivist viewpoint, but the textbooks of these subjects still have strong academic content, even though topics related to everyday life are included as examples and the nature of science is introduced. Because most science teachers depend on the textbooks and teachers' guides in teaching students, an innovation in terms of a curriculum and textbook would be expected to affect science classes. Therefore, it was considered that a comparison between the two grades would provide useful information on whether the new General Science was influencing the constructivist nature of classroom learning environments in grade 10.

Differences in students' perceptions of their learning environment between grade 10 and grade 11 were explored using a one-way multivariate analysis of variance (MANOVA) with the set of CLES scales as dependent variables. Because the Wilks' lambda criterion was found to be statistically significant ($p<0.05$), a corresponding one-way univariate analysis of variance (ANOVA) was examined for each of the CLES scales individually. Table 4 presents the observed scale means and the differences in scale means between grade 10 and 11. Grade 10 students perceived their environment as more constructivist for most scales except Uncertainty, and the differences were statistically significant ($p<0.01$) for the three scales of Personal Relevance, Shared Control, and Student Negotiation. But the effect sizes were not high (around a quarter of a standard deviation). It is also noteworthy that the actual mean score for Shared Control is lower than for other the other scales suggesting that students perceive their teachers are not sharing aspects of learning science with their students. Overall the results reported in Table 4 suggest that General Science's emphasis on relevance with everyday life, inquiry-centred learning, and social interaction had some effect on classroom environment, but that this positive effect is not big enough to change traditional science classes into highly constructivist-oriented ones. It is possible that more teacher development, particularly regarding teachers' readiness to implement a new curriculum based on constructivist principles into their science classes, is needed to improve science learning environments.

Table 4
Differences between Grade 10 and 11 Students

Scale	Version	Mean		Difference	Effect Size
		Grade 10	Grade 11		
Personal Relevance	Actual	16.57	15.53	1.04**	0.24
	Preferred	22.40	22.91	-0.51	
Uncertainty	Actual	18.02	18.17	-0.15	
	Preferred	19.12	19.41	-0.29	
Critical Voice	Actual	16.96	16.37	0.59	
	Preferred	21.03	21.98	-0.96*	-0.18
Shared Control	Actual	14.09	12.76	1.33**	0.29
	Preferred	18.02	17.70	0.32	
Student Negotiation	Actual	16.38	14.73	1.65**	0.32
	Preferred	20.21	19.77	0.44	

* $p<0.05$ ** $p<0.01$ *** $p<0.001$

Differences between Actual and Preferred Forms

Another pattern evident in Table 4 is the consistent difference existing between actual and preferred mean scores for all the five scales. Preferred means were higher than actual means for these five scales. This suggests that students would prefer to have more opportunities to be given personal relevance, to know the uncertain nature of science, to express their critical voice, to have a shared role in the class, and to negotiate meaning with other students than was perceived to be present in the science classroom. This pattern, in which Korean students prefer a more positive learning environment than the one actually present, replicates past research in several other countries (Fisher & Fraser, 1983; Hofstein & Lazarowitz, 1986; Moos, 1979).

Association between constructivist learning environments and students' attitudes

Table 5 reports associations between the five actual CLES scales and student attitudes toward the science class. Multiple regression analysis involving the whole set of CLES scales was conducted, in addition to a simple correlation analysis, to provide a more conservative test of associations between each CLES scale and attitude when all other CLES scales were mutually controlled.

Table 5
Statistically Significant Associations between CLES Scales (Actual form) and Student Attitude in terms of Simple Correlations (r) and Standardized Regression Coefficients (β)

Scale	Grade 10		Grade 11	
	r	β	r	β
Personal Relevance	0.39***	0.31***	0.29***	0.30***
Uncertainty	0.12*		0.24***	0.13*
Critical Voice	0.11*			
Shared Control	0.32***	0.20**	0.19**	
Student Negotiation	0.28***	0.18**	0.17**	
Multiple Correlation,		0.46**		

* p <0.05 ** p <0.01 *** p <0.001

An examination of the simple correlation coefficients in Table 5 indicates that there were statistically significant relationships (p<.05) between students' perceptions of learning environment and their attitudes toward the science class for most scales of CLES. Students' perceptions showed a statistically significant correlation with their attitudes for the scales of Personal Relevance, Shared Control, and Student Negotiation for grade 10 and for the scales of Personal Relevance, Uncertainty, and Shared Control for grade 11. Multiple correlations were also statistically significant (p<.001) for both grade 10 and grade 11 students. An examination of beta weights revealed that Personal Relevance was the strongest independent predictor of students' attitudes toward their science class.

SUMMARY AND IMPLICATIONS

The main purpose of this research was to investigate whether the science curriculum reform efforts in Korea had a positive effect on the classroom learning environment from a constructivist point of view. Grade 10 students perceived more positively their learning environment of General Science, which is designed so that students would learn about and understand basic science concepts through involvement in an inquiry process and negotiation, than grade 11 students who studied an academic-centred science curriculum. This result suggests that efforts of curriculum reform have produced some positive effects on improving the science learning environment.

In addition, three other achievements were reported in this study. First, a Korean-language version of the CLES was developed and found to be valid and reliable when used for the first time in Korea. Thus the instrument can be used by Korean science teachers and researchers to improve science teaching and student achievement. Second, there were statistically significant relationships between classroom environment and student attitudes. The results suggest that favourable student attitudes could be promoted in classes where students perceive more personal relevance, share control with their teachers and negotiate their learning. Third, there were differences between student perceptions of actual and preferred environment in that students tended to prefer a more positive environment than what was perceived to be present.

The present study produced several potentially fruitful results but typically indicated directions available to assess teachers' perceptions of their own classroom environments and differences between teachers' perceptions and those of their students could be a fruitful line of research. Previous learning environment research has indicated differences in the perceptions of boys and girls in the same classes and this also would be worth investigating. Qualitative studies also are needed to enhance our understanding of the results obtained from quantitative studies like this one.

Whilst a number of previous studies have examined science students' perceptions of their learning environments, this study is distinctive in that it is the first to be completed in Korea. A particular value of this study is that it identifies differing perceptions and outcomes between different grades of students, providing teachers with important information that could help improve the quality of the teaching and learning process in both grades, but particularly in grade 11.

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