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DEVELOPMENT, VALIDATION, AND USE OF A GREEK-LANGUAGE QUESTIONNAIRE FOR ASSESSING LEARNING ENVIRONMENTS IN GRADE 10 CHEMISTRY CLASSES

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ABSTRACT. This study describes the development and validation of a Greek-language instrument that can be used to assess grade 10 students' perceptions of their chemistry classroom environment as a means of showing differences between chemistry learning environments in Greece (Attica) and Cyprus. The development of the instrument was based on available learning environment questionnaires. The questionnaire was administered to 1,394 students from 49 chemistry classes in Attica, and the resulting data were analyzed to explore the reliability and the validity of the new instrument. The validated questionnaire was administered to 225 students from 15 classes in urban areas of Cyprus. The data analyses supported the questionnaire's internal consistency, discriminant validity, and ability to differentiate between classrooms. Effect sizes and independent samples *t* test analyses revealed differences between the two samples. Cypriot students viewed their chemistry classroom environment more favorably than did the Attica students. A possible cause for this difference could be the knowledge-centered aspect of the grade 10 chemistry curriculum in Greece compared to the corresponding tool-instrumental knowledge curriculum in Cyprus.

KEY WORDS: chemistry education, learning environment, high school, cross-validation, comparative study

Introduction

Although the classroom environment is a subtle concept, it can be assessed and studied. A considerable amount of work has been undertaken in many countries in developing methods that investigate how teachers and students perceive their work environment and its influence on their performance. Remarkable progress has been made over several decades in conceptualizing, assessing, and researching the classroom environment (Fraser, 1986, 2007; Fraser & Walberg, 1991;

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Wubbels & Levy, 1991). The use of qualitative methods in learning environment research (Tobin & Fraser, 1998) has provided a more in-depth understanding of learning environments. Many researchers have indicated that school and classroom environments, in particular, have a significant influence on students' outcomes (Fraser, 1994; Haladyna, Olsen, & Shaughnessy, 1982; Myers & Fouts, 1992; Simpson & Oliver, 1990; Talton & Simpson, 1987). Although learning environment research originated in Western countries, African and especially Asian researchers have made major, distinctive contributions in the last decade (Fisher & Fraser, 2003; Fraser, 2002; Goh & Khine, 2002).

Using students' perceptions to study educational environments can be contrasted with the external observer's direct observation and systematic coding of classroom communication and events (Brophy & Good, 1986). The notion that a distinct classroom environment exists began as early as the 1930s when Lewin (1936) recognized that the environment and its interactions with personal characteristics of the individual are determinants of behavior. Murray (1938) introduced the term *alpha press* to describe the environment as perceived by milieu inhabitants. Since then, the notion of a person–environment fit in education has been developed by Stern (1970) and Fraser & Fisher (1983). Defining the classroom or school environment in terms of the shared perceptions of students has the dual advantage of characterizing the setting through the eyes of the participants themselves and capturing data that the observer could miss or consider unimportant. Students have a good vantage point to make judgments about classrooms because they have encountered many different learning environments and have enough time in class to form accurate impressions.

Science education research that crosses national boundaries offers much promise for generating new insights for at least two reasons (Fraser, 1996). First, there is usually greater variation in variables of interest (e.g., teaching methods, student attitudes) in a sample drawn from multiple countries than a sample drawn from one country. Second, familiar educational practices, beliefs, and attitudes taken for granted in a country can be detected and questioned in studies involving teaching and learning from two or more countries. However, studies that compare science classroom learning environments in different countries have been limited (Aldridge, Fraser, & Huang, 1999; Aldridge, Fraser, Taylor, & Che, 2000; Dorman & Adams, 2004; Fisher, Goh, Wong, & Richards, 1997).

The purpose of the present study was to develop and validate a Greek-language instrument that could be used to assess Attican (a region in Greece) and Cypriot grade 10 students' perceptions of their learning environment in chemistry classes as a means of pinpointing differences between the two chemistry learning environments. Hence, it is expected that this study could offer significant contributions in the field of learning environments given that no related studies in Greece have been reported in the published science education literature.

Background

Research on classroom learning environments over the last 30+ years has spawned diverse research programs around the world and the creation of several learning environment instruments (Moos, 1979; Walberg, 1979). Walberg (1981) proposed a multifactorial, psychosocial theory of educational productivity that presents student learning as a function of three aptitude variables (age, ability, and motivation), two instructional variables (quantity and quality), and four psychosocial environments (home, classroom, peer group, and mass media); this theory has served as the foundation for most of the research in this field, as well as the instruments (Fraser, Walberg, Welch, & Hattie, 1987).

Learning Environments

Over the past few decades, a variety of valid and widely applicable questionnaires for assessing student's perceptions of the classroom environment have been developed (Fraser, 1994, 1998a). Additional research has established relationships between the classroom environment and student outcomes and has evaluated educational programs and identified determinants of learning environments as well (Fraser, 2002).

A milestone in the historical development of instruments in the field of learning environments occurred when Walberg and Moos began independent programs of research. Walberg developed the Learning Environment Inventory (LEI) as part of the research and evaluation activities of the Harvard Physics Project (Walberg, 1979; Walberg & Anderson, 1968), whereas Moos developed social climate scales for various human environments including the Classroom Environment Scale (CES; Moos, 1979; Moos & Trickett, 1974). These instruments were followed by the development of other important questionnaires including the My Class Inventory (Fisher & Fraser, 1981), a simplified version of the LEI for students at the primary school level, and the Questionnaire on Teacher Interaction (Wubbels & Levy, 1991) for the assessment of students' perceptions of their teacher's interpersonal behavior. Questionnaires have been developed to assess specific learning environments, such as the Constructivist Learning Environment Survey (CLES; Taylor, Dawson, & Fraser, 1995a, b; Taylor, Fraser, & Fisher, 1997) for measuring the extent to which constructivist approaches are being adopted and the Science Laboratory Environment Instrument (Fraser & McRobbie, 1995) for assessing dimensions that relate specifically to the learning environment of science laboratory classes. The What is Happening in this Class? (WIHIC) Questionnaire (Fraser, Fisher, & McRobbie, 1996) has been used to assess students' perceptions of the learning environment in different subject areas, at a range of grade levels, and in nine countries. Many instruments originating in English-speaking countries have been translated into several Asian languages (Fraser, 2002).

Although the use of questionnaires has led to many insights into learning environments, the field also includes many studies that have used qualitative or interpretative methods (Fraser, 1998b); considerable progress has been made in combining qualitative and quantitative methods in learning environments into mixed-methods research (Aldridge & Fraser, 2000; Fraser, 2002; Fraser & Tobin, 1991; Tobin & Fraser, 1998). This study draws on valid, economical, and widely applicable assessment instruments available in the field of learning environments, but it also extends prior research by cross-validating a new Greek-language instrument in Greece and Cyprus.

Educational Aims and the Nature of the Curricula

Both Greece and Cyprus are countries with a centralized public educational system that partially uses Greek as the language of instruction. The Ministry of Education and Religion in Greece and the Ministry of Education and Culture in Cyprus are responsible for the administration of education and the enforcement of educational policies. The ministries are also responsible for curriculum formulation and prescription of syllabi and textbooks. All the schools in each country must follow the same curriculum and use the same educational materials authorized by the central governments. The educational systems were launched under the ideals of equity of opportunity and the formation of citizens for a modern democratic society.

In both countries, education is divided into two levels: elementary (grades 1–6) and secondary (grades 7–12). Secondary education is realized through junior high school (gymnasium—grades 7–9) and high school (lyceum—grades 10–12). The first 9 years are compulsory for all students. High school consists of two types: Eniaio lyceum (academic orientation) and technical and vocational school (technical and vocational orientation). High schools offer diversity and encompass three distinct program curricula, all leading to a school-leaving certificate, the “Apolyterio” (Bouzakis, Chrisostomou, Filippou, Gagatsis, Kazamias, Papailiou-Keraunou, et al., 2004, p. 52–65; Tsaparlis, 2008).

Comparison of the two types of high schools in Greece and Cyprus reveals certain common features in their philosophical background and also some differences. One difference, which is connected with the concern of the present research, focuses on the main aim of upper secondary education. In Greece, according to law 2525/97, the goal for high school is, “providing education of a high level aiming at developing the students' initiative, creativity and critical thought” (Bouzakis et al., 2004, p. 62). Additional goals are: “a) providing students with the necessary knowledge and qualifications to continue their studies at the next educational level, and b) cultivating those students' skills that will facilitate their access after further specialization or instruction—to the job market” (p. 62–63). In Cyprus, the high schools place greater emphasis on the advancement of knowledge as an tool-instrumental (p. 63) and on the developmental role of the school and education. More specifically, it is stressed that the “provision of contemporary general knowledge should correspond to the needs of the social and economic development of the country.”

According to Persianis (1981), in Cyprus, during the period 1940–1970, a greater priority was given to the role of education, in general, and of technical and vocational education, in particular, on the economic efficiency and economic progress of the country. The defenders of the “economic factor [and the entailed economic role of education] were influenced by the British philosophy of life” (p. 87).

The educational system at the secondary level in both countries provides for diagnostic assessment, formative assessment, and final written examinations conducive to promotion. Formative assessment is conducted throughout the school year for continuous monitoring and control of the teaching–learning process. Continuous assessment in the upper division is on a scale of 1–20 and includes both oral and written assessments (quizzes, revision tests, class tests, and projects) supplemented by compulsory, internally set, final examinations in Greek, mathematics, and the subjects in each of the combinations. In the last year of the upper division, nationwide comprehensive final examinations ensure objectivity and uniformity of assessment. Following the final examination, an aggregate of marks based on the results determines the student's successful graduation. The “Apolyterio” is a qualification for employment in clerical positions and provides access to local and overseas tertiary education establishments (Bouzakis et al., 2004, p. 181–183).

Teacher preparation and certification is similar in both countries. A person with a university degree in the subject to be taught is eligible for inclusion in the official register of candidates for appointment. But, prior to permanent appointment, a secondary school teacher in Greece or Cyprus is required to attend the program of a preparatory training scheme for teachers (Kapsalis & Rampidis, 2006). The organization and conduct of the programs in both countries are undertaken by the Pedagogical Institutes, leading to a Certificate of Preservice Training. In Greece, attendance is required before the official commencement of the school term on the school premises, and the duration of courses lasts between 2 and 3 weeks. The program comprises school-related topics as well as topics relevant to behavior, teaching modes, and the educational process in general terms. The same applies to Cypriot teachers, except that the duration of their training lasts 12 months. The disparity in the length of the course lies in the fact that it is incumbent upon the Cypriot counterpart to implement specific teaching practices in tandem with their mentor at the school for a period of 6 months.

Especially in the case of Greece, teachers are subject specialists (physicists, chemists, biologists, and geologists) without having received special educational training. Despite this, they are called upon to teach all science subjects (Tsaparlis, 2008).

Grade 10 Chemistry in Greece and Cyprus

The grade 10 level mathematics, chemistry, and physics in Greece and Cyprus are taught in the Greek language as separate compulsory courses for all students. Both countries use prescribed curricula and textbooks that differ substantially in philosophy, goals, and approach.

In Greece, chemistry takes place basically in class for 2 h/week with class sizes ranging from 16 to 35 students. The principal characteristics of chemistry education are: (a) the chemistry curriculum includes six chapters/units (e.g., fundamental concepts of chemistry, acids–bases–salts, oxides, stoichiometry) where students learn through a continuous spiral ladder; (b) chemistry textbooks are based on a systematic curriculum with a consolidated content that contains few connections between chemistry and life; (c) educational practices focus on transmitting and acquiring fixed knowledge and adopt rather traditional teaching methods, as well as few chemistry demonstrations and laboratory activities; and (d) external factors (e.g., lack of coordination regarding the time schedule and deficiency of infrastructure) that frustrate teachers, limits their teaching strategies, and constrains the applications of advanced technologies.

In Cyprus, chemistry takes place exclusively in the laboratory for 1 h/week in groups ranging from 12 to 15 students. During the lesson, classes are divided into teams of four or five students. The main characteristics of chemistry education are: (a) the chemistry curriculum includes ten units with each unit having a short introduction covering the basic theoretical knowledge and two or three experiments (e.g., one unit deals with the elements, chemical compounds, mixtures, separation of mixtures, and includes three experiments); (b) the chemistry textbooks have a variety of connections between chemistry and life, and the coverage of concepts and theories is limited in comparison with the Greek textbooks; (c) classroom practices are student-centered with experiments following the discovery learning method in order to generate student interest and contain limited mathematics and problem-solving problems that require critical thinking; and (d) schedule limitations (1 h/week) make it difficult for teachers to help students learn through open inquiry and self-designed explorations due to the fact that the lesson occurs once a week.

A comparison of both educational systems leads to the conclusion that the Cypriot chemistry curriculum aims more at the development of students' skills and the use of general knowledge by all students, independent of the continuity of their studies in areas involving chemistry. The realization of the educational aims is achieved by the operation of an organized chemistry laboratory.

Research Design

The present test development and validation study commenced from a positivistic framework, favoring an objectivist view in which the main focus of data collection was the large-scale administration of a questionnaire. The research was carried out quantitatively by developing and using an instrument to document and compare learning environments in two distinctly different settings.

Context

The research took place in the city of Athens and its suburbs (the Attica region) and in several cities of Cyprus during a single school year, involving grade 10 students studying chemistry using the same language, but under two different curricula and approaches. This specific grade was selected due to the fact that senior school students tend to criticize chemistry more often than students in middle school (Osborne & Collins, 2000). Moreover, these students do not usually entertain as much angst towards university entry examinations as grades 11 and 12 students.

Methods

The present study aimed, in the first stage, to develop and validate a Greek-language instrument that could be used to assess grade 10 chemistry learning environments in Greece and Cyprus. In the second stage, the instrument and results were used to demonstrate the differences between chemistry learning environments in these two Greek-language countries. Therefore, this new instrument was developed using established research literature and instruments and validated with a large sample of Attica's students and cross-validated with a second sample of Cypriot students. Next, the results from the validated instrument for both groups of grade 10 students' perceptions of classroom learning environments in chemistry classes were compared.

Samples

The samples of students participating in this research were selected according to cluster random sampling techniques. The clusters encompassed 1,394 students from 49 classes in Attica and 225 students from 15 classes in Cyprus; all were from urban centers. The sample sizes corresponded to the proportion (~5%) of the grade 10 population in Attican public schools (25,210) and in Cypriot public urban schools (4,384). The resulting sample sizes were judged to be suitable for factor analysis (Tabacknick & Fidell, 1996) and likely to produce the required number of participants selecting each item response.

Design of Questionnaire

The development of a Greek-language instrument was realized by the selection and translation into Greek of the scales from existing questionnaires that assessed students' perceptions of their *actual* learning environment in science classes. The How Chemistry Class is Working (HCCW) instrument was constructed by taking into consideration the relevant scales of the *actual* form of questionnaires presented in the literature. Scales were adapted from widely used general classroom environment questionnaires, such as the CES (Fisher & Fraser, 1983; Moos, 1979; Moos & Trickett, 1987), CLES (Taylor et al., 1995a, b; Taylor et al., 1997), and the WIHIC (Fraser et al., 1996). The new HCCW instrument consists of five scales with a total of 36 items (see the Electronic Supplementary Material):

1. Innovation: the extent to which the teacher plans new, varied activities and techniques and encourages students to think creatively;
2. Personal relevance: the extent to which school chemistry connects with students' out-of-school experiences;
3. Competition: the extent to which students compete with one another for grades and recognition;
4. Involvement: the extent to which students show attentive interest, participate in discussions, do additional work, and enjoy the class;
5. Teacher support: the extent to which the teacher helps, becomes a friend, trusts, and shows interest in students.

Moos (1979) suggested that the personal relevance, involvement, and teacher support scales pertain to relationship dimensions—the degree of people's involvement in the environment and the assistance given to each other—while the competition scale pertains to personal development dimensions—the type and strength of personal relationships in the environment. The item response format of the HCCW instrument consisted of a five-point Likert scale (always—5, often—4, sometimes—3, seldom—2, never—1).

Construct Validity. The learning environments construct was addressed by the selection criteria and deliberations regarding the scales and items for the HCCW and rigorous translation of the English-language version into Greek. The scales of the instrument were chosen from established and widely used general questionnaires according to the basic criterion that their content corresponded to the dimensions of the chemistry classroom environments in Greece and Cyprus. The instrument needed to be functional in both a knowledge-centered (Greece) and an instrument-centered (Cyprus) learning environment. The use of WIHIC or CLES questionnaires would be most likely to result in the two samples of students interpreting some content differently. Specifically, students would interpret differently the investigation scale of the WIHIC questionnaire because it assesses the extent to which emphasis is placed on the skills and processes of inquiry and their use in problem solving and investigation. Similarly, students may not understand the meaning of the uncertainty scale in the CLES questionnaire because it measures the extent to which opportunities are provided for students to experience scientific knowledge as arising from theory-dependent inquiry. In addition, similar studies have demonstrated that the teacher support and involvement scales were evaluated as the most important dimensions of the science learning environment (Fraser & Tobin, 1989).

It should be noted that learning environment research involves the use of actual and personal forms. Some instruments represent attempts to evaluate students' perceptions of the “actual” classroom learning environment (Fraser, 1998b), while others involve the students' personal perceptions of their role in the classroom environment. Several studies have demonstrated that these types of measurements provide more essential information about each student when compared to measurements where the items refer to the students' perceptions of the learning environment in the class as a whole (Fraser et al., 1996).

The English version of the chosen scales and items of the HCCW questionnaire was translated into the Greek language by educators in Greece and Cyprus and then back-translated into English by an independent third party (Brislin, 1970). The back-translations were checked to ensure that the Greek version maintained the original meanings and concepts in the English version. In general, few difficulties arose in the translation process. The term *science* was replaced with the term *chemistry* to specify the content focus. The term *problem solving* in the involvement scale caused some concern; specifically, Greek students interpreted problem solving as a procedure involving only mathematical calculations while the Cypriot students interpreted it as a procedure involving additional problems regarding an experimental process.

Content Validity. Two expert panels of chemistry teachers from Greece (n=20) and Cyprus (n=16) explored the content validity of the HCCW. These expert panels were asked to evaluate which of the preliminary instrument's statements were representative of the grade 10 chemistry classroom environment for their country and then classify the items into one of the five thematic scales. Judgment criteria for the item analyses were set at 80% agreement to determine the representative or nonrepresentative statements. Items receiving less than 80% agreement were automatically excluded from further consideration. The representative items were classified into the five scales. The finally selected items were those that at least 60% of the judges classified as having the same thematic unity (Rubio, Berg-Weger, Tebb, Lee, & Raych, 2003). These analyses yielded the preliminary versions of scales with a total of 36 items: six items for the personal relevance scale, seven items for the innovation and the competition scales, and eight items for the teacher support and involvement scales. Finally, a pilot study was conducted in order to monitor students' capacity in understanding the items and the time required to complete the questionnaire. The data collection took 30 to 40 min, including clarifications by the researchers and the completion of questionnaires by students. During this procedure, the teacher was present in the class. The data collection over all sites lasted for 5 months.

Results

The data collected from the Greek and Cypriot samples were used to examine further the psychometrics (structural validity and reliability) of the questionnaire and to develop comparative results for the two samples. Because the factors for learning environment scales were expected to be slightly correlated, a principal axis factor analysis followed by a varimax rotation (Coakes & Steede, 2000) was conducted on the HCCW data. The reliability was explored by establishing the internal consistency of the instrument.

The five scales of the preliminary HCCW questionnaire were analyzed for each of the two samples separately, which means two-factor analyses were explored to determine if each operated as a unified cluster of items focused on measuring a specific learning environment feature. The Kaiser–Mayer–Olkin (K-M-O) measure of sampling the adequacy of the correlation matrix was used to determine an item's membership in the one-factor solution. The K-M-O values obtained in the current study (higher than 0.65) indicate the appropriateness of the factor analysis. The two criteria for retention of any item were that its factor loading must be at least 0.40 on its own scale and less than 0.40 on all other scales (Hair, Anderson, Tatham, & Black, 1998).

Validity and Reliability of the HCCW

Determination of which factors were significant and interpretable involved the inspection of the eigenvalues' plot (eigenvalue criterion). Application of this criterion regarding the factor analyses of the preliminary instrument revealed that three factors (personal relevance, involvement, and teacher support) were valid and should be retained resulting in a 22-item final version of the HCCW. Two preliminary scales (innovation and competition) did not meet the criterion and were removed from further consideration. Table 1 demonstrates the factor loadings of all items in the final version of the HCCW for the Attican and Cypriot samples and factor analyses.

In addition, the percentage of variance and the eigenvalue are shown in Table 1. The percentage of variance for different factors ranged from 8.67 to 29.90 for Attica and from 9.13 to 25.45 for Cyprus. The eigenvalue for different factors ranged from 1.91 to 6.60 for Attica and from 2.00 to 5.60 for Cyprus. Overall, the pattern of factor loadings for the HCCW provides good support for the a priori structure of this three-factor instrument (Hair et al., 1998).

The final HCCW and the three scales retained were explored further to establish the reliability and validity of the scales. Cronbach's alpha reliability coefficient (α) was used as an index of the internal consistency of each scale with a minimal value of α=0.70 (Nunnally, 1978). Table 2 shows that the internal consistency reliability of the HCCW scales ranged (a) from 0.79 to 0.89 for Attica and from 0.77 to 0.81 for Cyprus, with the individual as the unit of analysis, and (b) from 0.86 to 0.97 for Attica and from 0.82 to 0.88 for Cyprus, with the class mean as the unit of analysis. These results suggest that the internal consistencies for the scales of the final HCCW were satisfactory. The internal consistency reliability estimates for each of the three factors of the HCCW, using both the individual and the class mean as the unit of analysis, were comparable with other instruments on which some HCCW scales were based (Aldridge & Fraser, 2000; Aldridge et al., 1999; Aldridge et al., 2000; Aldridge, Laugksch, Seopa, & Fraser, 2006).

The discriminant validity (mean correlation between scales) for the three scales of the final HCCW ranged (a) from 0.24 to 0.43 for Attica and from 0.24 to 0.35 for Cyprus, with the individual as the unit of analysis, and (b) from 0.39 to 0.56 for Attica and from 0.18 to 0.42 for Cyprus, with the class mean as the unit of analysis. These results suggest that scales in the final version of the HCCW assess distinct constructs, although there is a modest degree of overlap. However, the factor analyses results (Table 1) attest to the independence of factor scores on the final version of the HCCW.

An analysis of variance (ANOVA) with class membership as the main effect was used to determine whether each HCCW factor was able to distinguish between the perceptions of students in different classes. The η^2 statistic was calculated to provide an estimate of the strength of association between class membership and each HCCW factor in order to ascertain whether factor scores varied with class membership. The

TABLE 1

Factor loadings for HCCW final version in Attica (Greece) and Cyprus

	Personal relevance		*Involvement*		*Teacher support*	
	Attica	*Cyprus*	*Attica*	*Cyprus*	*Attica*	*Cyprus*
I learn about the world outside of school.	0.67	0.71				
My new learning starts with problems about the world outside of school.	0.55	0.60				
I learn how chemistry can be part of my out-of-school life.	0.64	0.55				
I get a better understanding of the world outside of school.	0.67	0.62				
I learn interesting things about the world outside school.	0.68	0.72				
What I learn has nothing to do with my out-of-school life.	0.41	0.41				
I discuss ideas in class.			0.43	0.50		
I give my opinions during class discussions.			0.52	0.46		
The teacher asks me questions.			0.42	0.41		
My ideas and suggestions are used during classroom discussions.			0.53	0.53		
I ask the teacher questions.			0.46	0.41		
I explain my ideas to other students.			0.67	0.76		
Students discuss with me how to go about solving problems involving mathematical calculations.			0.60	0.65		
I am asked to explain how to solve problems involving mathematical calculations.			0.61	0.70		
The teacher takes a personal interest in me.					0.70	0.56
The teacher goes out of his/her way to help me.					0.70	0.62
The teacher considers my feelings.					0.65	0.60
The teacher helps me when I have trouble with the work.					0.70	0.60
The teacher talks with me.					0.76	0.57
The teacher is interested in my problems.					0.67	0.53
The teacher moves about the class to talk with me.					0.64	0.41
The teacher's questions help me to understand.					0.60	0.54
Eigenvalue	1.91	2.00	2.42	5.60	6.60	2.29
Variance (%)	8.67	9.13	10.98	25.45	29.90	10.40

TABLE 2

Internal consistency reliability (Cronbach's α coefficient), discriminant validity (mean correlation with other factors), and ability to differentiate between classrooms (ANOVA results) for two units of analysis for the final version of the HCCW in Attica (Greece) and Cyprus

		α Reliability		*Mean correlations with other factors*		*ANOVA* η^2	
Factor	*Unit of analysis*	*Attica*	*Cyprus*	*Attica*	*Cyprus*	*Attica*	*Cyprus*
Personal relevance	Individual	0.79	0.77	0.24	0.24	0.09***	0.08**
	Class mean	0.91	0.86	0.39	0.18		
Involvement	Individual	0.80	0.81	0.43	0.35	0.09***	0.07*
	Class mean	0.86	0.82	0.56	0.42		
Teacher support	Individual	0.89	0.79	0.28	0.30	0.27***	0.11***
	Class mean	0.97	0.88	0.46	0.39		

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

ANOVA results that are reported in Table 2 indicate that each HCCW factor differentiated significantly among classes ($p<0.001$). The η^2 statistic (a measure of the proportion of variance accounted for by class membership) for the different HCCW factors ranged from 0.09 to 0.27 for Attica and from 0.07 to 0.11 for Cyprus.

Overall, the results suggest that the scales and the final version of the HCCW are valid and reliable for use in low-risk research studies. The HCCW should provide reasonable documentation of the learning environments in grade 10 chemistry classes in both Attica and urban areas in Cyprus.

Differences Between Attica and Cyprus in Chemistry Learning Environments

The collected data provided an overview of the chemistry learning environments in each country, and a starting point from which comparisons could be made. The average item mean (the factor mean divided by the number of items in the scale) was calculated for the items for each factor of the HCCW instrument for both samples to provide an indicator of students' perception of each learning environment item on a strongly agree to strongly disagree continuum. Then the mean of each class was calculated based on the scores extracted and used as the basis for comparison between the two samples to provide an indicator of students' perception of learning environment factors on a strongly agree to strongly disagree continuum. Table 3 provides the average item means, using the class as the unit of analysis, for the actual version of the learning environment scores for both samples. The average item mean for the different HCCW factors ranged from 2.61 to 3.06 for Attica and from 2.91 to 3.27 for Cyprus.

TABLE 3

Average item mean, average item standard deviation, effect size, and t test for independent samples for differences in perceptions of classroom environment between Attica (Greece) and Cyprus for the class mean as the unit of analysis

	Average item M		*Average item SD*		*Difference between samples*	
	Attica	*Cyprus*	*Attica*	*Cyprus*	*Effect size*	*t*
Personal relevance	3.06	3.23	0.27	0.22	−0.69	−2.36*
Involvement	2.61	2.91	0.21	0.20	−1.46	−4.92**
Teacher support	2.88	3.27	0.51	0.26	−1.01	−3.97*

*$p<0.05$, **$p<0.001$

Using the class as the unit of analysis, *t* tests ($df=62$) for independent samples were used to investigate any differences in factor scores between Attica and Cyprus. In order to estimate the magnitude of the differences, and in addition to their statistical significance, effect sizes were calculated as recommended by Thompson (1998a, b). Table 3 shows the magnitude of the differences calculated using effect sizes for three factors in the HCCW. These effect sizes (higher than 0.5) indicated a substantial difference between Attica and Cyprus in the learning environment factors; *t* tests of the differences in factor scores between Attica and Cyprus were statistically ($p<0.05$) significant. Cypriot students, compared to their Attican classmates, held more favorable perceptions of the chemistry classroom environment in terms of the HCCW factors. Specifically, Cypriot students perceived that chemistry lessons had more relevance to their everyday lives, their involvement in learning procedure was more active, and their teacher's behavior was friendlier. There was a statistically significant difference ($p<0.001$) for the involvement factor and a statistically significant difference ($p<0.05$) for the personal relevance and teacher support factors.

Discussion and Conclusions

The present study is different from the majority of studies that have taken place in the field of educational research in science in Greece. More specifically, it is the first time that a Greek-language instrument has been developed and validated with the aim to being used to assess Attican and Cypriot grade 10 students' perceptions of their learning environment in chemistry classes. The HCCW questionnaire was used in order to demonstrate that expected differences between different chemistry curricula in Greece and Cyprus can be detected.

The development of the HCCW instrument was based on relevance scales of widely used assessment questionnaires available in the field of learning environments. Data collected from a sample of 1,394 students belonging to 49 classes from public schools in Attica, Greece were analyzed to determine the validity and reliability of the instrument. This study was extended by the additional validation realized by data collection and analyses of 225 grade 10 students from 15 classes in Cyprus. The factor analyses of the HCCW instrument revealed three factors (personal relevance, involvement, and teacher support) from the 22 items for the students in Greece and Cyprus. The internal consistency reliability (Cronbach's α) for each factor in the questionnaire—using both the individual and the class mean as the unit of analysis and the ability to differentiate between classrooms—was found to be satisfactory and comparable with past studies that used other instruments. The ANOVA result indicated that the final form of the HCCW instrument was able to differentiate between the perceptions of students in different classes.

Overall, the validation provides support for the confident future use of the HCCW by teachers, teacher educators, and researchers in grade 10 chemistry classes in Attica and in urban Cyprus. However, it should be acknowledged that a limitation of this new instrument is that its three scales encompass only one of the three general dimensions that Moos (1979) claimed were essential for the assessment of any human environment. In addition, future research is needed in order to validate the scales of the preliminary HCCW that were considered problematic and removed from the present study.

Effect sizes and *t* tests for independent samples were used to investigate the differences in factor scores between students' perceptions of their actual learning environments in chemistry class. There was a significant difference regarding the three factors in the HCCW. The findings indicate that the grade 10 Cypriot students perceived the chemistry classroom environment more favorably than their Attican classmates, which could be predicted from the different teaching approaches in the two educational settings. Greek instruction is characterized by the "chalk-and-talk" teaching and learning approach, while in Cyprus, the laboratory approach prevails.

The chemistry learning environments in Greece and Cyprus are influenced by the nature of the curriculum. In Greece, the grade 10 chemistry curriculum remains, to a large extent, traditional; this means it is knowledge-centered with intellectualism being the prevailing philosophical aspect. Everyday educational practices focus on transmitting and acquiring fixed knowledge and adopting rather traditional teaching methods. Moreover, the competition-driven and examination-driven nature of the curriculum obliges students to be constantly occupied with grades, rewards, and penalties at the expense of active learning, while, at the same time, it reinforces the existence of private tuition colleges, named *frontistiria* (Matsagouras, 1999a, b). *Frontistiria* are privately owned learning institutions offering complementary training to students preparing for examinations or who need additional instruction. The above-mentioned phenomenon is intensified by the fact that only a few teachers regard grade 10 chemistry as preparatory, which means that the level of the knowledge offered is decided, to a large extent, by the demands of the subject matter of the chemistry lesson in the classes following. Kazamias & Zambeta (2000) suggested that Greek high schools are not oriented to the promotion of culture, or *paideia*, but they are acting as learning institutions that prepare young people for entrance to higher educational institutes (e.g., universities) or the labor market. Tsaparlis (2008) pointed out that there are two approaches to correct the problematic situation: one is to change or adapt the curricula and the other is to change the mood of all those involved in educational policy-making, curricula development, and the teacher themselves.

Correspondingly, in Cypriot grade 10 chemistry, a greater emphasis is placed on the advancement of an "tool-instrumental" knowledge approach. As a result, chemistry lessons include fundamental experiments that aim at the student developing skills in the laboratory. As shown by the results of relevant research (Tobin & Espinet, 1989; Tobin, Espinet, Byrd, & Adams, 1988; Tobin & Gallagher, 1987a, b; Tobin & Malone, 1989), the laboratory environment promotes interaction and cooperation between students when conducting an experiment, while it facilitates active learning by means of discussion and the exchange of information.

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REFERENCES

Aldridge, J. M., & Fraser, B. J. (2000). A cross-cultural study of classroom learning environments in Australia and Taiwan. *Learning Environments Research, 3*, 101–134.

Aldridge, J. M., Fraser, B. J., & Huang, I. T. C. (1999). Investigating classroom environments in Australia and Taiwan. *Journal of Educational Research, 93*, 48–62.

Aldridge, J. M., Fraser, B. J., Taylor, C. P., & Che, C. C. (2000). Constructivist learning environments in a cross-national study in Taiwan and Australia. *International Journal of Science Education, 22*(1), 37–55.

Aldridge, J. M., Laugksch, C. R., Seopa, A. M., & Fraser, B. J. (2006). Development and validation of an instrument to monitor outcomes-based learning environments in science classrooms in South Africa. *International Journal of Science Education, 28*(1), 45–70.

Bouzakis, S., Chrisostomou, C., Filippou, G., Gagatsis, A., Kazamias, A., Papailiou-Keraunou, E., et al. (2004). *Report of the educational reform committee*. Nicosia: Ministry of Education and Culture.

Brislin, R. (1970). Back translation for cross-cultural research. *Journal of Cross Cultural Psychology, 1*, 185–216.

Brophy, J., & Good, T. L. (1986). Teacher behavior and student achievement. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed., pp. 328–375). New York: Macmillan.

Coakes, J., & Steede, G. (2000). *SPSS for Windows: analysis without anguish (Version 10.0 for Windows)*. New York: Wiley.

Dorman, R. J., & Adams, J. (2004). Associations between students' perceptions of classroom environment and academic efficacy in Australian and British secondary schools. *Westminster Studies in Education, 27*(1), 69–85.

Fisher, D. L., & Fraser, B. J. (1981). Validity and use of My Class Inventory. *Science Education, 65*, 145–456.

Fisher, D. L., & Fraser, B. J. (1983). Validity and use of Classroom Environment Scale. *Educational Evaluation and Policy Analysis, 5*, 261–271.

Fisher, D. L., & Fraser, B. J. (2003). Emergence of learning environment research in South Africa: Editors' introduction. *Learning Environments Research: An International Journal, 6*, 229–230.

Fisher, D. L., Goh, S. C., Wong, A. F. L., & Richards, T. W. (1997). Perceptions of interpersonal teacher behaviour in secondary science classrooms in Singapore and Australia. *Journal of Applied Research in Education, 25*, 125–133.

Fraser, B. J. (1986). *Classroom environment*. London: Croom Helm.

Fraser, B. J. (1994). Research on classroom and school climate. In D. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 493–541). New York: Macmillan.

Fraser, B.J. (1996). *NARST's expansion, internalization and cross nationalization: History in the making*. Presidential Address presented at the Annual Meeting of the National Association for Research in Science Teaching, St. Louis, MO.

Fraser, B. J. (1998a). Classroom environment instruments: Development, validity and applications. *Learning Environment Research, 1*, 7–33.

Fraser, B. J. (1998b). Science learning environments: Assessment, effects and determinants. In B. J. Fraser & K. Tobin (Eds.), *The international handbook of science education* (pp. 527–564). Dordrecht: Kluwer.

Fraser, B. J. (2002). Learning environments research: Yesterday, today and tomorrow. In S. C. Goh & M. S. Khine (Eds.), *Studies in educational learning environments* (pp. 1–27). Singapore: World Scientific.

Fraser, B. J. (2007). Classroom learning environment. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 103–124). Mahwah: Erlbaum.

Fraser, B. J., & Fisher, D. L. (1983). Student achievement as a function of person environment fit: A regression surface analysis. *British Journal of Educational Psychology, 53*, 89–99.

Fraser, B. J., & McRobbie, J. (1995). Science laboratory classroom environments at schools and universities: A cross-national study. *Educational Research and Evaluation, 1*, 289–317.

Fraser, B. J., & Tobin, K. (1989). Student perceptions of psychosocial environment in classrooms of exemplary science teachers. *International Journal of Science Education, 11*, 19–34.

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.

Fraser, B. J., & Walberg, H. J. (eds). (1991). *Educational environments: Evaluation, antecedents and consequences*. London: Pergamon.

Fraser, B. J., Walberg, H. J., Welch, W., & Hattie, J. (1987). Syntheses of educational productivity research. *International Journal of Educational Research, 11*, 145–252.

Fraser, B. J., Fisher, D. L., & McRobbie, J. (1996). *Development, validation and use of personal and class forms of a new classroom environment instrument.* Paper presented at the Annual Meeting of the American Educational Research Association, New York, NY.

Goh, S. C., & Khine, S. M. (eds). (2002). *Studies in educational learning environments: An international perspective*. Singapore: World Scientific.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis*. Upper Saddle River: Prentice-Hall.

Haladyna, T., Olsen, R., & Shaugnessy, J. (1982). Relations of student, teacher and learning environment variables to attitudes to science. *Science Education, 66*(5), 672–687.

Kapsalis, A., & Rampidis, K. (2006). Introduction to teachers' training: Evaluation of the effort. *Education in Science, 10*(3), 257–273. In Greek.

Kazamias, A. M., & Zambeta, E. (2000). Crisis and reform in Greek education—A modern Greek Sisyphus: Analysis of texts. In S. Lindbland & T. Popkewitz (Eds.), *Public discourses on education governance and social integration and exclusion: Analyses of policy texts in European contexts. Uppsala Reports on Education 36* (pp. 81–97). Sweden: Uppsala University.

Lewin, K. (1936). *Principles of topological psychology*. New York: McGraw.

Matsagouras, I. (1999a). *School classroom, space, group, discipline, method*. Athens: Gregory. In Greek.

Matsagouras, I. (1999b). *Theory of instruction: The personal theory as framework of stochastic-critical analysis*. Athens: Gutenberg. In Greek.

Moos, H. (1979). *Evaluating educational environments: Procedures, measures, findings and policy implications*. San Francisco: Jossey-Bass.

Moos, H., & Trickett, J. (1974). *Classroom environment scale: Manual and form R*. Palo Alto: Consulting Psychologists.

Moos, H., & Trickett, J. (1987). *Classroom environment scale manual* (2nd ed.). Palo Alto: Consulting Psychologists.

Murray, A. (1938). *Explorations in personality*. New York: Oxford University Press.

Myers, E., & Fouts, T. (1992). A cluster analysis of high school classroom environments and attitude toward science. *Journal of Research in Science Teaching, 29*(9), 929–937.

Nunnally, J. C. (1978). *Psychometric theory*. New York: McGraw-Hill.

Osborne, J., & Collins, S. (2000). *Pupils' and parents' views of the school science curriculum*. London: King's College.

Persianis, P. (1981). *The political and economical factors as the main determinants of educational policy in independent Cyprus (1960–1970)*. Nicosia: Pedagogical Institute.

Rubio, D. M., Berg-Weger, M., Tebb, S. S., Lee, E. S., & Raych, S. (2003). Objectifying content validity: Conducting a content validity study in social work research. *Journal of Social Work Research, 27*, 94–104.

Simpson, D., & Oliver, S. (1990). A summary of the major influences on attitude toward and achievement in science among adolescent students. *Science Education, 74* (1), 1–18.

Stern, G. (1970). *People in context: Measuring person–environment congruence in education and industry*. New York: Wiley.

Tabacknick, B., & Fidell, L. (1996). *Using multivariate statistics* (3rd ed.). New York: HarperCollins.

Talton, L., & Simpson, D. (1987). Relationships of attitude toward classroom environment with attitude toward and achievement in science among 10th grade biology students. *Journal of Research in Science Teaching, 24*(6), 507–525.

Taylor, C., Dawson, V., & Fraser, B. J. (1995a). *Classroom learning environments under transformation: A constructivist perspective*. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco.

Taylor, C., Dawson, V., & Fraser, B. J. (1995b). *A constructivist perspective on monitoring learning environments under transformation*. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco.

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

Thompson, B. (1998a). *Five methodology errors in educational research: The pantheon of statistical significance and other faux pas*. Invited address presented at the Annual Meeting of the American Educational Research Association, San Diego.

Thompson, B. (1998b). Review of "what if there were no significance tests?". *Educational and Psychological Measurement, 58*, 334–346.

Tobin, K., & Espinet, M. (1989). Impediments to change: Application of peer coaching in high school science. *Journal of Research in Science Teaching, 26*, 105–120.

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

Tobin, K., & Gallagher, J. (1987a). The role of target students in the science classroom. *Journal of Research in Science Teaching, 24*, 61–75.

Tobin, K., & Gallagher, J. (1987b). What happens in high school science classrooms? *Journal of Curriculum Studies, 19*, 549–560.

Tobin, K., & Malone, J. (1989). Differential student participation in whole-class activities. *Australian Journal of Education, 33*, 320–331.

Tobin, K., Espinet, M., Byrd, S. E., & Adams, D. (1988). Alternative perspectives of effective science teaching. *Science Education, 72*, 433–451.

Tsaparlis, G. (2008). The rivalry among the separate science subjects for dominance in secondary education: The case of Greece and beyond. In R. K. Coll & N. Taylor (Eds.), *Science education in context: An international examination of the influence of the context on science curricula development and implementation* (pp. 145–159). Rotterdam: Sense.

Walberg, H. J. (1979). *Educational environments and effects: Evaluation, policy and productivity*. Berkeley: McCutchan.

Walberg, H. J. (1981). A psychological theory of educational productivity. In F. Farley & N. Gordon (Eds.), *Psychology and education: The state of the union* (pp. 81–108). Berkeley: McCutchan.

Walberg, H. J., & Anderson, J. (1968). Classroom climate and individual learning. *Journal of Educational Psychology, 59*, 414–419.

Wubbels, T., & Levy, J. (1991). A comparison of interpersonal behaviour of Dutch and American teachers. *International Journal of Intercultural Relations, 15*, 1–18.

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