

Learning environment profiles of Turkish secondary biology classrooms

Perry den Brok · Sibel Telli · Jale Cakiroglu ·
Ruurd Taconis · Ceren Tekkaya

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Abstract The purposes of this study were to examine how Turkish students perceived their biology classroom environment, how their perceptions compared to those of students in other countries, and what classroom learning environment profiles could be discerned in Turkish high school biology classrooms. Data were gathered from 1,474 high school students in four inner city schools, in Bursa, Turkey. A total of 11 biology teachers participated in the study with 52 of their classes. Data on students' perceptions of their learning environment were collected with the What Is Happening In this Class? (WIHIC) questionnaire. Results indicated that Turkish classrooms were perceived as being low in terms of Teacher Support and high in terms of Task Orientation. Six distinct classroom learning environment profiles were found: the 'self-directed learning classroom', 'task-oriented cooperative learning classroom', 'mainstream classroom', 'task-oriented individualised classroom', 'low-effective learning classroom' and 'high-effective learning classroom'. The most common profile was the 'mainstream classroom' for which all WIHIC scales had medium–high scores.

P. den Brok (✉) · R. Taconis
Eindhoven School of Education, Eindhoven University of Technology,
P. O. Box 513, 5600 MB Eindhoven, The Netherlands
e-mail: p.j.d.brok@tue.nl

R. Taconis
e-mail: r.taconis@tue.nl

S. Telli
Graduate School of Teaching, University of Koblenz-Landau, Koblenz, Germany
e-mail: telli@uni-landau.de

J. Cakiroglu · C. Tekkaya
Faculty of Education, Department of Elementary Education,
Middle East Technical University, Ankara, Turkey

J. Cakiroglu
e-mail: jaleus@metu.edu.tr

C. Tekkaya
e-mail: ceren@metu.edu.tr

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Rationale

The promotion of favourable attitudes towards science and the improvement of science achievement of students are among the main objectives of science education in many countries (Fraser 1986; Lyons 2006; OECD 2006) and Turkey is no exception in this respect (Sjoberg 2004). According to the results of the third cycle of the Program for International Student Assessment project (PISA 2006), the achievement of Turkish students in science is not satisfactory. Turkey received a score below the international average, with girls being outperformed by boys. In the Third International Mathematics and Science Study (TIMSS) in 1999, Turkey ranked 33rd out of 38 countries (Kilic 2002; Ozden 2007). Baykul (1990) showed that Turkish students' attitudes towards science decrease sharply between Grades 5 and 11. In the ROSE (the Relevance of Science Education) project, an international study of secondary education students' attitudes and learning in science with over 40 participating countries, Turkey had a score below the international average (Sjoberg and Schreiner 2006). Other recent studies of Turkish students' attitudes towards science also showed moderate to negative attitudes among students. For example, Cokadar and Kulce (2008) found medium attitudes among a sample of 503 students at public schools, with 2.5% of the students showing (strongly) negative attitudes towards science. Telli (2006) found medium attitude scores for students' science enjoyment, relevance, confidence and effort for a sample of 7,484 secondary science students. From this perspective, there is a clear need for further and deeper insight into the factors that might cause negative attitudes towards and achievement in science in Turkey.

Some scholars have argued that this disappointing situation might be the result of the nature and status of science education in Turkey, as well as the manner in which teachers are prepared for the profession. Ozden (2007), for example, identified a number of problems with Turkish (secondary) science education: teachers receiving insufficient training; large class sizes; insufficient time allocation for science; an overloaded curriculum; an over-emphasis on lecturing (providing information) and passivity of students; traditional testing methods (multiple-choice); few laboratory opportunities (and insufficient conditions for teaching); and a disconnection between science and other subjects. Gencer and Cakiroglu (2007) reported that many Turkish science teachers experience discipline problems, that lecturing and discussion are still the most common teaching methods in Turkey, and that teachers strongly rely on their textbooks. They also reported that the quality and status of teacher education might be blamed for some of these problems, and discussed a number of (policy) developments that have recently occurred in Turkey, particularly in (science) teacher training.

With respect to biology education, the situation seems to be no different from what has been described above with respect to Turkish (science) education in general. For example, although it has been found that biology textbooks are important in shaping and improving Turkish students' attitudes towards biology (Kete and Acar 2007), biology textbooks were found to be unsuitable for creating effective biology education or for realising effective biology laboratory lessons (Oztas and Ozay 2004; Yesilyurt 2006); these books could be more interactive, containing textual as well as visual materials, and they should be better

linked to technology. According to Oztas and Ozay (2004), biology teachers are also insufficiently prepared during teacher training for teaching biology laboratory lessons. Teachers and students reported other problems with respect to biology laboratory lessons, including a general absence of links between these lessons and textbook-based lessons and a lack of laboratory materials and resources (Yesilyurt 2006). Moreover, teachers seem to have more favourable perceptions of biology lessons than their students and both groups feel that there is a shortage of technology and visual materials. Students argue that better support for individual work in biology lessons is needed (Yesilyurt 2006).

It seems that, although Turkey has faced several nation-wide reforms in teacher education (Cakiroglu and Cakiroglu 2003; Grossman et al. 2007), these reforms directly addressed the curriculum, rather than being aimed at teacher behaviour and reflection on this behaviour. Teachers' reflecting on their teaching could be helpful for the improvement of teaching and the classroom learning environment in the direction of less teacher-centred, more practice-oriented lessons that stimulate students' attitudes towards science. The lack of suitable instruments for mapping Turkish science classrooms has been argued as one of the possible reasons for this (Acikgoz et al. 2003; Tuzun 2006).

Learning environments research has been involved for a long time in the creation of instruments (mainly questionnaires) for mapping students' and teachers' *perceptions* of their science classroom learning environments, linking these perceptions to student outcomes and using them in the improvement of teaching practice (Fraser 1998, 2002, 2007; Wubbels and Brekelmans 1998; Wubbels et al. 2006). However, while the topic of learning environments research has been a popular one in many Western countries, it only recently has received attention from non-Western countries (Fraser 1998, 2002).

Fraser (2007) advocated that more research aimed at the improvement of science education should be conducted, and proposed a five-step procedure for this: (1) assessment of actual and preferred perceptions of students (and teachers) of the learning environment; (2) providing teachers with feedback on the results of these perceptions (including reporting on areas with large differences between these perceptions); (3) reflection and discussion of the results; (4) creating interventions aimed at improving the environment in the desired direction; and (5) reassessment of the actual and preferred perceptions to evaluate any changes. If teachers can compare their own views with those of their students or their own preferences (steps 1 and 2), differences between each of these views can provide interesting clues for changing behaviour (den Brok et al. 2006a; Fisher et al. 1995; Fisher and Rickards 2000; Fraser 2007). Teacher reflection on their own and their students' perceptions of teaching and the learning environment can be further enhanced if information containing these perceptions is presented in various ways (Wubbels 1992). *Images* or *profiles* are one of these alternative ways of presenting such information, along with written information on item, scale or (higher-order) dimension scores. Images and profiles are powerful tools for reflection because they can be used to conceptualise complex and interrelated information, because they can summarise information into (smaller) chunks that are easier to comprehend, and because they can stimulate associations and links within the teachers' own knowledge if they are accompanied with powerful labels (e.g. Copeland et al. 1993; Weber and Mitchell 1996; Wubbels 1992).

The creation and empirical investigation of typologies (a set of profiles) is not a common practice in (science) learning environments research. Moos (1979) used the Classroom Environment Scale to identify five clusters which describe the following learning environment orientations: control; innovation; affiliation; task completion; and competition. Dorman et al. (2006) conducted a cluster analysis to create a typology of secondary science classrooms with the Technology-Rich Outcomes-Focused Learning

Environment Inventory (TROFLEI). Their study partially focused on similar dimensions of the learning environment as the present study. It revealed a common overall pattern in science classes, as well as meaningful differences between classes that could be described in terms of five profiles: exemplary; safe and conservative; non-technological teacher-centred; contested technological; and contested non-technological classes. Outside the domain of science education more typologies of profiles are available, particularly with respect to teaching styles (Bennett 1976; Flanders 1970; Good 1979; Schultz 1982; Ramsay and Ransley 1986). Most of these typologies distinguish between directive and non-directive approaches to teaching, in which non-directive teachers emphasise support, innovative instructional procedures and flexible rules and directive teachers emphasise control and seek to develop competitive, task-oriented classes. Research on teacher–student interpersonal relationships, which traditionally has been linked strongly to the domain of (science) learning environments research, has produced an eight-fold typology of interpersonal teaching styles consisting of ‘authoritative’, ‘tolerant-authoritative’, ‘directive’, ‘tolerant’, ‘uncertain-tolerant’, ‘uncertain-aggressive’, ‘repressive’ and ‘drudging’ teachers (Brekelmans et al. 1993a). This typology has been replicated in different countries, such as The Netherlands and USA (Brekelmans et al. 1993a), Australia (Rickards et al. 2005) and Turkey (Telli 2006). Moreover, the typology has shown strong connections to student outcomes, with some styles producing higher-achieving and more-motivated students (Brekelmans et al. 1993a; Wubbels et al. 2006).

The present study aimed to create a typology of Turkish science (e.g. biology) classroom learning environments based on students’ perceptions. The following research questions were investigated:

1. What is the *average profile* of the Turkish science classroom learning environment in secondary education? To what degree is this profile similar to or different from science learning environments in other countries?
2. Which *typologies* can be discerned in biology classes in Turkey, based on (class means of) students’ perceptions of their learning environment?
3. To what degree are the typologies identified in research question 2 able to explain variance in students’ *outcomes*?
4. To what degree are the typologies identified in research question 2 evenly distributed across *school and class variables*, such as school or grade level?

Student perceptions of science classroom learning environments

The instrument used in the present study to map students’ perceptions of their biology classroom learning environment was developed by Fraser et al. (1996) and is known as the What Is Happening In this Class? (WIHIC) questionnaire. There are several reasons for focusing on this particular instrument. First, the WIHIC combines relevant dimensions from several other science learning environment instruments (the Questionnaire on Teacher Interaction, Science Laboratory Environment Inventory and Constructivist Learning Environment Survey; see Fraser 2002), such as investigation and relationships between teacher and students (Dorman 2003). Because of this feature, the instrument maps a more comprehensive area of science learning environments than many of the other existing learning environment instruments. Also, the WIHIC includes salient topics and scales from these existing instruments. Secondly, the WIHIC is one of the most widely-used instruments in the domain of learning environments research and has been validated in a number

of countries. As such, the instrument has proven to be cross-culturally valid (e.g. Dorman 2003), which is an advantage compared to some of the country-specific instruments that exist in the field. Thirdly, the instrument is capable of reliably measuring students' perceptions of important elements of their learning environment and has demonstrated predictive validity for both achievement in science and students science-related attitudes (e.g. Fraser 2002). Fourth, due to the limited number of items (56 in total) and scales (7 in total), the instrument is easy to use in the classroom and only occupies small amounts of participating students' and teachers' time. See Table 2 for some typical items from the WIHIC.

The WIHIC measures a wide range of dimensions that are important to the current situation in classrooms. It includes relevant dimensions from past learning environment questionnaires and combines these with dimensions that measure particular aspects of constructivism and other relevant factors operating in contemporary classrooms (Dorman 2003). A description of each scale in the WIHIC is presented in Table 1.

The WIHIC covers the three major dimensions distinguished by Moos' (1979) characterising all human learning environments: *relationship*, *personal growth* and *system maintenance and change* (see Table 1). Whereas relationship dimensions are concerned with the nature and intensity of interpersonal relationships, personal growth dimensions focus on opportunities for personal development and self-enhancement. System maintenance and system change dimensions assess the extent to which the environment is orderly, clear in expectations, maintains control and is responsive to change.

The WIHIC has been reported as useful and valid across a number of countries and school subjects (e.g. Aldridge and Fraser 2000). Research seems to indicate that the reliabilities of the scales (Cronbach's α coefficient) are usually above 0.70 at the student level and above 0.85 at the class level (Table 2). Intra-class correlation coefficients, which are an indication of the degree to which an instrument is capable of distinguishing between different classes, have been reported as being rather low for the WIHIC, ranging roughly between 5 and 15% (den Brok et al. 2006b; Dorman 2003). Nevertheless, these values are equivalent to findings with respect to student views of climate and affective outcomes in school effectiveness research (Scheerens and Bosker 1997), for which the majority of the

Table 1 Scale description for each scale of the WIHIC questionnaire

WIHIC scale	The extent to which...	Moos (1979) dimension
Student cohesiveness	...students are friendly and supportive of each other.	Relationship
Teacher support	... the teacher helps, befriends and is interested in students.	Relationship
Involvement	... students have attentive interest, participate in class and are involved with other students in assessing the viability of new ideas.	Relationship
Investigation	...there is emphasis on the skills and of inquiry and their use in problem-solving and investigation.	Personal growth
Task orientation	... it is important to complete planned activities and stay on the subject matter.	Personal growth
Cooperation	... students cooperate with each other during activities.	Personal growth
Equity	... the teacher treats students equally, including distributing praise, question distribution and opportunities to be included in discussions.	System maintenance and change

Table 2 Typical item and reliability for each WIHIC scale in the present study

Scale	Typical item	α Reliability	
		Student	Class
Student cohesiveness	I work well with other class members.	0.78	0.88
Teacher support	The teacher helps me when I have trouble with the work.	0.86	0.94
Involvement	I give my opinion during class discussions.	0.80	0.88
Investigation	I find out answers to questions by doing investigations.	0.85	0.85
Task orientation	I know how much work I have to do.	0.75	0.89
Cooperation	When I work in groups in this class, there is teamwork.	0.80	0.86
Equity	I am treated the same as other students in this class.	0.87	0.94

variance in such variables has been reported at the student level and with percentages around or below 10% at the class and teacher levels.

Exploratory and confirmatory factor analyses (e.g. Dorman 2003) indicated that the items of the WIHIC usually have factor loadings above 0.40 on their a-priori scales and lower loadings on other scales. Moreover, the factor structure has been shown to be invariant across grade levels, countries, cultures and gender (Dorman 2003), which suggests its usefulness in studying multicultural and heterogeneous school populations. Average correlations between the scales of the WIHIC have been reported as being between approximately 0.20 and 0.50, indicating that each of the seven scales measures distinct, though partly overlapping, elements of the classroom environment.

A number of studies have investigated secondary education students' perceptions of their science classroom environment as measured with the WIHIC. Data¹ are available from Australia (Aldridge and Fraser 2000; Dorman 2001; Fraser et al. 2010), Canada (Zandvliet and Fraser 2004), India (Koul and Fisher 2005), Indonesia (Fraser et al. 2010; Wahyudi and Treagust 2003), Korea (Kim et al. 2000), Taiwan (Aldridge and Fraser 2000), Singapore (Chionh and Fraser 2009) and the USA (den Brok et al. 2006b; Wolf and Fraser 2008). In Table 3, scale scores from each of these studies are presented. As can be seen, in Indonesia (except for the Fraser et al. 2010 study) and Korea, the science classroom is consistently perceived most positively of all countries, while the learning environment is rated lowest of all countries for Teacher Support, Involvement, Investigation and Equity in the USA, lowest for Investigation and Task Orientation in Canada, and lowest in Cooperation in one Australian study. Moreover, in all countries in Table 3, students perceived relatively high amounts of Student Cohesiveness, Task Orientation, Cooperation and Equity, while Teacher Support, Involvement and Investigation were rated lower. Although differences between the countries in Table 3 should be interpreted with caution—studies used different sampling methods and cross-cultural adaptation issues for the instruments could be present—they do show that learning environments are perceived differently in different countries. Therefore, it seems plausible that different learning environment profiles might be present within and between different countries.

Only a few prior studies with the WIHIC have been conducted in the Turkish context. Based on the status of Turkish secondary science education and the problems reported (see Rationale section), one might expect perceptions of relatively low Investigation,

¹ We only report studies that have been published in peer-reviewed journal articles and that report WIHIC scale scores for single countries. Obviously, more studies from a larger number of countries are available in other sources, particularly conference papers.

Table 3 Mean WIHIC scale scores reported in a number of international studies

Study	Country	Scale mean						
		Student cohesiveness	Teacher support	Involvement	Investigation	Task orientation	Cooperation	Equity
Aldridge and Fraser (2000)	Australia	0.74	0.52	0.52	0.49	0.74	0.70	0.74
Dorman (2001)	Australia	0.79	0.58	0.54	0.49	0.73	0.66	0.71
Fraser et al. (2010)	Australia	0.70	0.48	0.46	0.38	0.69	–	0.65
Zandvliet and Fraser (2004)	Canada	0.62	–	0.55	0.41	0.59	0.67	–
Koul and Fisher (2005)	India	0.79	0.63	0.60	0.61	0.81	0.73	0.75
Fraser et al. (2010)	Indonesia	0.69	0.51	0.49	0.50	0.59	–	0.63
Wahyudi and Treagust (2003)	Indonesia	0.95	0.71	0.66	0.63	0.94	0.81	0.90
Kim et al. (2000)	Korea	0.91	0.61	0.61	0.60	0.84	0.82	0.77
Aldridge and Fraser (2000)	Taiwan	0.74	0.51	0.47	0.47	0.72	0.67	0.69
den Brok et al. (2006b)	USA	0.74	0.43	0.46	0.41	0.78	0.68	0.64
Wolf and Fraser (2008)	USA	0.61	0.44	0.37	0.39	0.58	0.56	0.57

Scale means have been transformed into scores between 0 and 1, representing the proportion of the maximum possible score. Transformation was necessary, as different studies reported scores differently (e.g. sum scores, item averages, different score ranges, and occasionally different numbers of items). The study by Chionh and Fraser (2009) was not included in the table, because it did not report any WIHIC scale mean scores

Cooperation and Equity, but relatively high amounts of Teacher Support and Task Orientation. Okan (2006) studied 152 university students' perceptions of one English-as-Foreign Language course and found their perceptions to be low and similar to those reported in the USA study (den Brok et al. 2006b), except for Involvement and Equity, which were rated much higher. Cakiroglu et al. (2007) studied 24 elementary education science classes (871 students). Compared to the studies reported in Table 3, students in their study reported high amounts of Teacher Support, Involvement and Investigation, average amounts of Student Cohesiveness, Task Orientation and Cooperation, and low amounts of Equity. However, none of these Turkish studies focused on secondary education.

Creating typologies of learning environments

To date, the most comprehensive attempt to create a typology of learning environments was the study by Brekelmans et al. (1993a; based on Brekelmans 1989). This study included a number of steps to arrive at a typology of teacher–student interpersonal profiles in Dutch secondary physics classes. Using data gathered with the QTI (the Questionnaire on Teacher Interaction; see Wubbels et al. 2006), a 77-item student questionnaire mapping the teacher–student interpersonal relationship, researchers conducted cluster analyses (Aldenderfer and Blashfield 1984; Everitt 1980) to derive a typology of interpersonal teaching styles (e.g. Brekelmans et al. 1993a). The typology found was further validated by observations in classrooms showing qualitative differences between each of the eight types. A separate hand-sort of teaching profiles (e.g. visual representations of scale scores on the QTI) conducted by the researchers (e.g. Brekelmans et al. 1993a) also resulted in a set of types similar to the one found by statistical analyses. The eight interpersonal types were finally linked to student outcomes to test whether they could explain significant amounts of variance (Brekelmans et al. 1993b).

According to Brekelmans (1989), it is important in the typology construction process to look for differences between types with respect to the magnitude within each scale (*elevation*), with respect to variance in the scales (*scatter*) and with respect to the overall pattern displayed in the scale scores (*shape*). She therefore suggested using the 'complete linkage' method in SPSS or related statistical software to group classes and the 'similarity ratio' or 'squared Euclidian distances' to determine whether a class belongs to a specific type. She also suggested using an analysis of variance (ANOVA) on scale scores with the constructed typology as the explanatory variable, to check if sufficient amounts of variance can be explained by the cluster outcomes. By doing so, the optimal cluster solution (in terms of the number of types) can be established.

However, while several studies have been conducted into profiles of teacher interpersonal behaviour, typologies have rarely been created using other science learning environment instruments (such as the WIHIC).

Method

Sample

The participants of this study were 1,474 students (Grades 9–11) from 52 classes (11 teachers) in four inner city schools, in Bursa, Turkey. In terms of student gender, 829

(56.5%) girls and 606 (41.3%) boys were sampled; 33 students (2.2%) made no indication of gender. Grade-level distribution was as follows: 54.8% of the students were in Grade 9, 25.5% in Grade 10 and 19.8% in Grade 11. Class sizes in the schools varied from 19 to 41 students, with an average of 28 students. In terms of class composition variables, the sample was diverse. The average percentage of girls and boys varied between classes, but no class consisted uniquely of girls or boys.

It was possible to check representativeness for Turkey as a whole for a small number of student background variables in the data set. The sample contained relatively more female students compared to the country as a whole ($\chi^2 = 127.72$; $p = 0.00$), more students in Grade 9 and less students in Grade 10 ($\chi^2 = 128.14$; $p = 0.00$).

Instrumentation

To assess students' perceptions of their learning environment, the Turkish version of the WIHIC was administered to all students of participating classes and schools (for more information on its development process, see Telli et al. 2006). Several analyses were undertaken to investigate its validity. First, the α reliability coefficient ranged between 0.78 (Student Cohesiveness) and 0.87 (Equity) at the student level and between 0.85 (Investigation) and 0.94 (Teacher Support and Equity) at the class level (see Table 2).

Also, correlations between the WIHIC scales were computed, in order to see whether they assessed distinctively different aspects of the learning environment (see Table 4). The scales seemed to measure distinct aspects, but also showed some overlap (correlations ranged between 0.29 and 0.53). This was particularly true for Task Orientation and Investigation (0.53), Involvement and Teacher Support (0.51), and Cooperation and Student Cohesiveness (0.50).

Students' affective outcomes were assessed by asking them to respond to a five-item Likert-type scale regarding their attitude towards biology. In addition, report card grade, an indication of students' achievement in biology, was used as outcome measure. These two outcome variables were chosen because the study involved multiple grade levels and school types, making the use of standardised tests impossible. Moreover, the use of student attitudes towards their subject made comparison possible with previous learning environment studies using similar outcome measures.

Table 4 Scale intercorrelations (student level) for the WIHIC

Scale	Scale intercorrelations						
	Student cohesiveness	Teacher support	Involvement	Investigation	Task orientation	Cooperation	Equity
Student cohesiveness	1						
Teacher support	0.32	1					
Involvement	0.45	0.51	1				
Investigation	0.32	0.43	0.50	1			
Task orientation	0.32	0.35	0.39	0.53	1		
Cooperation	0.51	0.33	0.42	0.41	0.37	1	
Equity	0.29	0.48	0.43	0.38	0.45	0.38	1

All correlations are significant at the 0.025 level (two-sided)

The items of the attitude scale asked about *enjoyment* (“I enjoy my Biology lessons.”), *usefulness* (“Biology is important for my later career.”), *feeling competent* (“I am not afraid to be given a turn during the Biology lesson.”) and *time investment* (“I also work on Biology tasks after school time.”) with respect to biology. Cronbach’s α coefficient for this scale was 0.82; correlations between the items ranged from 0.33 to 0.69. On average, students appeared moderately motivated for biology: on a scale from 0 to 1, the sample average was 0.39 ($SD = 0.16$). WIHIC scale scores and student outcome measures were linearly transformed to a score between 0 and 1 to represent proportion scores (of the maximum possible score) and enhance interpretation (see also Table 3).

Analysis

To answer the first research question, WIHIC scale averages were computed for the entire sample, and these were compared to the results reported in Table 3.

To answer the second research question, a typology of learning environment profiles was established by conducting a cluster analysis of class mean scale scores with SPSS. Following suggestions by Brekelmans (1989), squared Euclidian distances were used to distinguish between groups and the complete linkage and Ward methods were used to establish cluster profiles. To verify the stability of the cluster solution, we also conducted cluster analyses with other estimation methods (single linkage, complete linkage, median) that are not reported in this article. Mean scale scores of clusters were computed. The clusters were interpreted and given a label based on a graphical profile. An analysis of variance (ANOVA) for the seven scale scores, with the constructed typology as the explanatory variable, was used to check if sufficient amounts of variance could be explained in a scale score by the cluster division. Cluster analyses were conducted to test a range of solutions between two and eight profiles. In solutions with seven or eight clusters, some clusters were very small in size while not being very different in terms of average scale scores from other clusters. Solutions with four or less clusters seemed to explain small amounts of variance in some WIHIC scales.

Also, cluster differences in student outcomes were established using a variance analysis (research question 3). Finally, to further investigate the validity of the solution, profiles were cross-tabulated with some of the background variables (research question 4), such as class size, grade level and school (identification number).

Results

Average Turkish biology classroom profile

In Table 5, scale means and standard deviations for the entire sample can be found. Turkish students’ perception scores were highest for Task Orientation (0.74), followed by Equity (0.69) and Student Cohesiveness (0.67), but somewhat lower for Cooperation (0.60), Involvement (0.58) and Investigation (0.56), and low for Teacher Support (0.46).² However, compared to previous studies conducted in other countries, Turkish students perceived their classroom environments less favourably on all scales than students in India (Koul and Fisher 2005), Indonesia (Wahyudi and Treagust 2003) and Korea (Kim et al.

² Scale scores were regarded as ‘high’ when being above 0.70, ‘medium’ when being between 0.50 and 0.70 and ‘low’ when being below 0.50.

Table 5 WIIHC scale means and standard deviations for entire sample and each of the six profiles

Profile	No. of classes	Student cohesiveness		Teacher support		Involvement		Investigation		Task orientation		Cooperation		Equity	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Average		0.67	0.06	0.46	0.09	0.58	0.06	0.56	0.06	0.74	0.06	0.60	0.06	0.69	0.08
Self directed learning classroom	9	0.70	0.06	0.34	0.05	0.53	0.03	0.53	0.04	0.70	0.03	0.60	0.03	0.59	0.04
Task-oriented cooperative learning classroom	9	0.71	0.02	0.52	0.05	0.62	0.03	0.61	0.02	0.78	0.05	0.63	0.04	0.71	0.03
Mainstream classroom	14	0.66	0.03	0.47	0.03	0.54	0.05	0.59	0.03	0.73	0.03	0.60	0.04	0.72	0.04
Task-oriented individualised classroom	7	0.59	0.04	0.43	0.04	0.58	0.03	0.54	0.04	0.78	0.05	0.54	0.02	0.69	0.03
Low-effective learning classroom	6	0.61	0.04	0.42	0.06	0.50	0.06	0.56	0.02	0.65	0.02	0.55	0.04	0.62	0.03
High-effective learning classroom	7	0.73	0.06	0.59	0.04	0.61	0.06	0.68	0.05	0.81	0.02	0.69	0.05	0.82	0.06
<i>F</i>		14.07		31.82		20.23		9.45		19.08		15.48		28.83	
<i>p</i>		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
Variance explained (%)		61		78		51		69		68		63		76	

2000). In fact, scores for Student Cohesiveness, Teacher Support, Cooperation and Equity were lower in Turkey than in most of the countries reported in Table 3 (except for Canada), and perception scores for Investigation, Involvement and Task Orientation were medium to low compared to other countries.

A typology of learning environment profiles in Turkish biology classes

Cluster analyses indicated that a solution involving six profiles explained significant amounts of variance in the scales and profiles seemed optimally different. Moreover, the six-profile solution also emerged as most suitable in cluster analyses in different estimation methods. Thus, further analyses were conducted based on these six clusters which were given a label based on a graphical profile (Fig. 1) of cluster scale means (see Table 5).

First, according to Fig. 1, the overall pattern in scale scores appears very similar for all profiles. Because the cluster profiles intersect only a small number of times, it seems that Turkish biology classes mainly differ with respect to the magnitude of the learning environment dimensions, and not so much with respect to differences in emphasis on one or more dimensions. Second, as can be seen from the standard deviations in scale scores in Table 5, the clusters still display some overlap with respect to individual scales; overall patterns rather than single scale scores are thus needed to identify classes as belonging to one of the profiles.

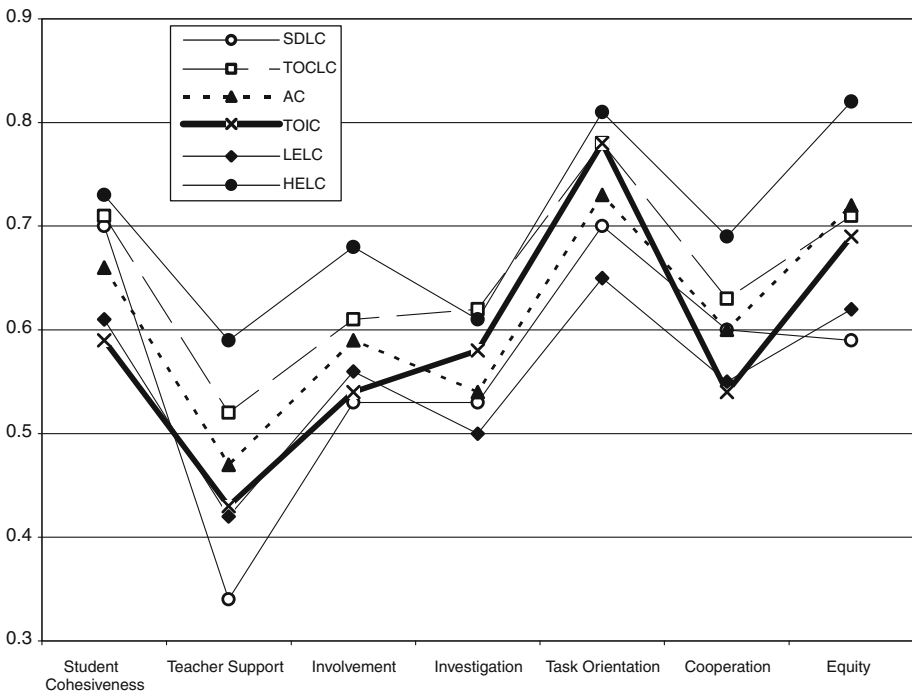


Fig. 1 Six profiles of Turkish biology classrooms *SDLC* Self-directed learning classroom, *TOCLC* Task-oriented cooperative learning classroom, *AC* Mainstream classroom, *TOIC* Task-oriented individualised classroom, *LELC* Low-effective learning classroom, *HELIC* High-effective learning classroom

The clusters can be described (and interpreted) as follows. The first cluster was named ‘self-directed learning classroom’ because its scale means were low for Teacher Support, high for Student Cohesiveness and Task Orientation and medium for the other scales. This profile received the lowest scores of all profiles on Teacher Support, Involvement and Equity, and it was found in 9 classes (17.3%). The second cluster was labelled ‘task-oriented cooperative learning classroom’ and is characterised by high Student Cohesiveness, Task Orientation and Equity, and medium scores for all other elements. This profile had the highest rating of all profiles for Investigation and the second highest rating for Cooperation, and it was found in 9 classes (17.3%). The third cluster had high scores on Task Orientation and Equity, but a low score on Teacher Support (with medium scores on the other scales); its scores were in-between most other profiles on each of the scales and it was therefore labelled as ‘mainstream classroom’. This profile was most common and appeared in 14 classes (26.9%). The fourth cluster was characterised by a low score on Teacher Support and a high score on Task Orientation (with medium scores on the rest), but it received the lowest scores of all profiles on the Student Cohesiveness and Cooperation scales. Therefore, it was named ‘task-oriented individualised classroom’. This profile was found in 7 classes (13.5%). The last two clusters, five and six, were named, respectively, ‘low-effective learning classroom’ and ‘high-effective learning classroom’. The former was typical because of its low score on Teacher Support and medium scores on all other scales, being lowest of all clusters on Investigation and Task Orientation, and second lowest on the remaining scales. The latter had the highest scores of all clusters on all scales except for Investigation (second highest score); its scores were high for Student Cohesiveness, Task Orientation and Equity and medium for all other scales. The ‘low-effective learning classroom’ was found in 6 classes (11.5%) and the ‘high-effective learning classroom’ in 7 classes (13.5%).

Learning environment profiles and student outcomes

According to Table 6, ‘high-effective learning classrooms’ had the highest mean scores on students’ attitudes towards Biology, followed by ‘task-oriented individualised classrooms’ and ‘task-oriented cooperative learning classrooms’. The lowest mean attitude scores were obtained in ‘self-directed learning classroom’ and ‘low-effective learning classroom’. An

Table 6 Mean and standard deviation for each cluster for attitudes and achievement and ANOVA results for between-cluster differences

Cluster	Attitude		Achievement	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Self-directed learning classroom	0.33	0.04	0.76	0.10
Task-based cooperative learning classroom	0.40	0.04	0.76	0.16
Mainstream classroom	0.37	0.04	0.69	0.13
Subject oriented individualised classroom	0.44	0.09	0.69	0.13
Low-effective learning classroom	0.34	0.04	0.77	0.12
High-effective learning classroom	0.47	0.03	0.79	0.15
<i>F</i>	9.21		0.89	
<i>p</i>	0.00		0.49	
Variance explained (%)	50		9	

analysis of variance showed that there were statistically significant differences among the attitudes scores of the six distinct clusters, with the typology explaining 50% of the between-class differences in attitudes towards Biology. The same result was not observed for students' report card achievement grades; no significant differences between profiles could be found in terms of class average achievement.

Learning environment profiles and their distribution across schools and classes

As indicated in the analysis section, the cluster solution was also cross-tabulated with a number of background characteristics. It seemed that the profiles were similarly distributed across the four schools ($\chi^2 = 17.94$; $df = 15$; $p = 0.27$). In a similar fashion, no different distribution of profiles was found with respect to grade levels ($\chi^2 = 7.31$; $df = 10$; $p = 0.69$). However, the profiles seemed related to class size. In the analyses, class size was recoded into an ordinal variable with four categories (<25 students; 26–30 students; 31–35 students; >36 students). Results suggested that classes with 31–35 students or 36 students and more often were classified as 'task-oriented cooperative learning classroom' or 'task-oriented individualised classroom', while smaller classes were classified relatively more often as 'mainstream classroom', 'high-effective learning classroom' or 'low-effective learning classroom' ($\chi^2 = 21.31$; $df = 15$; $p = 0.01$).

Discussion

Conclusion and interpretations

In the present study, we investigated secondary education students' perceptions of their biology classroom environments by using the WIHIC questionnaire. With respect to the first research question, students in the sample rated their learning environment high in terms of Task Orientation, low in Teacher Support and medium in Student Cohesiveness, Involvement, Investigation, Cooperation and Equity. These findings only partially supported our expectations of high ratings for Teacher Support, Involvement and Task Orientation and low ratings for Investigation, Cooperation and Equity given the situation in science education reported in the Rationale section. However, compared to previous studies conducted in other countries, perceptions of Student Cohesiveness, Teacher Support, Cooperation and Equity were lower in Turkey than in most of the countries reported in Table 3, and perceptions of Investigation, Involvement and Task Orientation were medium to low compared to other countries. In this respect, our findings align with expectations and some of the problems reported by Ozden (2007) and Gencer and Cakiroglu (2007), such as large class sizes, overloaded curricula and an over-emphasis on expository teaching methods.

As for the second research question, we identified six profiles, namely, the 'self-directed learning classroom', 'task-oriented cooperative learning classroom', 'mainstream classroom', 'task-oriented individualised classroom', 'low-effective learning classroom' and 'high-effective learning classroom'. The 'mainstream classroom' was found to be the most common profile in biology classes. The second most common profile was the 'task-oriented cooperative learning classroom'. All profiles had a relatively similar overall pattern (resembling patterns found in other countries), with high scores on Task Orientation, low scores on Teacher Support and few intersections with the other scales. Nevertheless, reported differences in scale scores between the six profiles were comparable to or even

larger than differences between studies from different countries (as reported in Table 3) and the typology was able to explain differences in scale scores, students' attitudes towards science and class size (research question 4). Therefore, we feel justified in distinguishing between the six profiles found.

As for association between profiles and outcomes (research question 3), 'high-effective learning classrooms' and 'task-oriented individualised classrooms' seemed to evoke more positive attitudes towards the subject. Finding more positive attitudes for these two profiles is not surprising considering the highly centralised and prescriptive mode of education in Turkey. It seems logical that students favour classes in which teachers help them to pass the central examinations, particularly by visibly discussing the curriculum content. This is reflected by some of the items in the attitude scales that relate to elements such as feeling competent and perceived usefulness of the subject.

Limitations and implications

There are a number of limitations of the present study which might have implication for further research. First, the study was limited by its reliance on (student) perception data. Subsequent research is needed to verify the consistency and accuracy of the present findings through use of multiple methods and measures. Conducting interviews and videotaping lessons might provide and enable a broader and more comprehensive description of a typology of science learning environments, in general, and biology learning environments, in particular. Second, we conducted this investigation with only 52 classes of 11 teachers in four inner-city schools located in Bursa, one of the big cities in Turkey. Therefore, results cannot be easily generalised to the country's population as a whole. Moreover, the stability of the profiles cannot be determined at this point, given the small sample size. Future studies that involve qualitative data, more teachers, different subjects, and different cities or regions can show whether the profiles found were typical or indicative of a wider population. Cross-cultural studies or studies involving samples in other countries might shed more light on the question of whether the typology found is unique to the Turkish context. While the general pattern found resembles that in other countries, perception scores were found to be lower than those in most other countries. Third, student outcomes were not optimally measured in this study. Because students' attitudes were measured with a small set of items, future studies could link profiles to more fine-grained attitude instruments and even distinguish between attitudinal elements such as pleasure, interest, effort, relevance and confidence. The fact that our typology could not explain differences in report card achievement grades might be explained by the fact that this measure tends to show less variance between classes than (standardised) achievement tests (Levy et al. 2003; Wubbels et al. 2006). Moreover, report card grades have been found to display lower associations with learning environment scales than do achievement tests (Fraser 2007; Wubbels et al. 2006).

Fourth, the analyses in this study were conducted at the class level (e.g. aggregated data) as the study attempted to create class profiles of the learning environment. However, by doing so, much within-class variation was ignored. This implies that, at the person/student (idiosyncratic) level, more profiles might be present in the data. The investigation of such within-class variation went beyond the scope of the present study but might be a topic for future research.

Several implications can be drawn from the results of the present study. First, teacher education and policy could focus on stimulating a number of learning environment elements, such as creating equal opportunities for boys and girls, realising teaching methods

that involve cooperative work, laboratory work and investigation, and providing stronger teacher support. Our findings indicate that Turkish students rated their biology classrooms particularly low on these elements compared to students in other countries. Second, the profiles identified in this study could be used for reflection, discussion and improvement using procedures such as those advocated by Fraser (2007), as they provide an additional and instant picture of the classroom. Teachers can use the profiles (and their labels) in conjunction with student/class and self-perception scores on the scales and items to obtain feedback and reflect on their behaviour. Important in this respect is whether teachers can recognise these profiles when observing their own classroom or the classrooms of other teachers. It is clear that, while this study might have helped in taking a first step in the desired direction, more research is needed. Third, the results of our study suggest that improvement in some of the conditions in Turkish science education—such as curricular load or class size—already might lead to different (more favourable) classroom profiles. For example, it was found that larger classes more often can be classified in one of the less effective profiles and that such classes are more likely to rate their teachers lower in terms of Teacher Support, Investigation or Equity.

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