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The Nominal Group Technique and the environmental evaluation of university classrooms

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Abstract

Research on conventional classrooms shows the impact of environmental design in teacher and students behavior. Researchers use to focus on innovations, though the row per column model is the dominant design in undergraduate and higher education levels. The present article is centered on the diagnostic of conventional classrooms problems through students' opinions. Data gathering uses a highly structured group technique (Nominal Group Technique, NGT) developed in the area of program planning and scarcely used in socio-environmental psychological research. Initial results show how NGT data should be transformed and analyzed in order to reduce possible biases and increase validity. A theory-based classification system composed by eight environmental and one non-environmental categories, useful for the evaluation of conventional classrooms, is proposed. Conditioning elements and task-oriented facets are emphasized. Internal structure of the system suggests the existence of an ecological structural model centered in a close vs. distant dimension.

Key-words: Environmental evaluation. Nominal Group Technique. Classroom design.

La Técnica del Grupo Nominal y la evaluación ambiental de aulas universitarias

Resumen

La investigación sobre aulas convencionales muestra el impacto del diseño ambiental sobre el comportamiento de profesores y estudiantes. Los investigadores suelen interesarse por las aulas innovadoras, a pesar de que el modelo de filas por columnas es el diseño dominante en los niveles de secundaria y de educación superior. El presente artículo se centra en el diagnóstico de los problemas de las aulas convencionales a través de la opinión de

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los estudiantes. Los datos se obtienen utilizando una técnica grupal altamente estructurada (Técnica del Grupo Nominal, TGN), desarrollada en el área de la planificación de programas y escasamente aplicada en la investigación psico-socio-ambiental. Los resultados iniciales muestran cómo deben ser transformados y analizados los datos TGN con el objetivo de reducir posibles sesgos e incrementar la validez. Se propone un sistema de clasificación teóricamente fundamentado, compuesto por ocho categorías ambientales y una categoría no ambiental. Se destaca la relevancia de los aspectos del acondicionamiento y los elementos relacionados con el desarrollo de las tareas en el aula. La estructura interna del sistema sugiere la existencia de un modelo ecológico estructural centrado en una dimensión espacial cercano-distante.

Palabras clave: Evaluación ambiental. Técnica del Grupo Nonimal. Diseño de aulas.

Introduction

Classroom environment has broad effects on the psychological and behavioral experience of both students and teachers. Previous research has dealt with pupils' environmental preferences (Cohen & Trostle, 1990), impact of distractor stimulation (Ahrentzen & Evans, 1984), and other physical factors influencing academic performance, such as position in the classroom (MacPherson, 1984) or whether there is direct natural lighting (Küller & Lindsten, 1992). Environmental research on classroom quality use to focus on lower education, and innovation beyond the conventional row per column design (open classroom, soft classroom; Gump, 1987; Wong, Sommer & Cook, 1992), though innovations elicit new problems related to the lack of definition of spaces and increasing environmental distractors. Several authors find problems of anxiety, cognitive overload, increased student off-task behavior and lost of time as intrinsic characteristics of open class classrooms when compared to the conventional design (Coterell, 1984; Gump, 1987; Stone, 2001). Cognitive overload and synergic conflict (task coordination problems) are the preferred theoretical explanations for these results. Though usually rejected because of their environmental weaknesses, these problems claim for a reflection on conventional designs, most of all when noting that it is the dominant design in our higher educational institutions.

The classroom ecological setting is defined as a physically and time-limited space, in which two main actors (teachers and students) display a program of interrelated behavior (Gump, 1987). Classroom quality is referred to in so far as the support that its arrangement, structure, and sociophysical features lend to the daily reoccurrence of the program setting (Stokols, 1978). Adequate coordination of behavior and the correct manning of human and non-human elements, as well as the absence of distractors are also relevant criteria of quality. Environment as a structure of opportunities is the main perspective for sustaining this conception of classroom design evaluation (Fernández-Ramírez & Rebolloso, 2002).

The program is phenomenologically characterized by a high degree of flexibility, allowing the person to adapt and also make it compatible with other interests, habits, and goals relevant to the situation. Cultural values and norms require that phenomenological issues be considered. MacPherson (1984) suggests that classroom quality refers to the student's and teacher's personal satisfaction with it, and to the learning of social values implicit in the dependence and hierarchical relationships established among classmates and with the teacher.

Besides flexible development of the program, classroom evaluative experience depends on individual specific meanings (Corraliza, 1987). Thus, classroom quality finally refers to individual attitudes in terms of evaluation, activation, impact, and control, following the traditional dimensions of the environmental emotional experience (Russell & Snodgrass, 1987; Ward & Russell, 1981).

Previous research mainly focused on elementary and undergraduate levels of education. This article tries to expand towards higher education institutions, keeping the focus on conventional classroom design. First, some antecedents on classroom environmental quality will be reviewed. Some notions on diagnostic evaluation will be revised after, proposing the Nominal Group Technique (NGT) as a valid tool for problem analysis and environmental planning. The theoretical basis for environmental design draws on two sources, a knowledge of social science, and the perceptions of the foremost stakeholders (designers and users). Both are combined in the empirical study, creating a theory-based classification system to analyze classroom environmental problems (Rebolloso, Fernández-Ramírez & Cantón, 2002).

Classroom environmental evaluation

Classroom evaluation may adopt a place-centered perspective oriented toward the description of human and non-human elements with design planning as the goal, or a person-centered perspective oriented toward measurement of psychological factors, with an understanding of the environment-behavior relationships as the goal (Gifford, 2002). In the first case, expert collaboration is required to judge the relevance of quality criteria (Environmental Quality Indexes, *EQI*). In the second, the user's judgment is systematized as Perceived Environmental Quality Indexes (*PEQI*), which analyze the psychological perception and experience in the classroom (Bell, Fisher, Baum & Greene, 1990). Both kinds of data are gathered through scales useful to the evaluation of environmental design, with the only central criteria of reliability, discriminative power, and sensitiveness (Craik & Feimer, 1987).

Rebolloso et al. (2002) analyze the environmental quality of conventional university classrooms, focusing on both technical and psychological quality. The measure of technical quality was systematized with a set of environmental facets. The resultant structure (factorial dimensions) lays out classroom space in two differentiated zones: the *teacher's area* includes some typical furniture such as the platform, armchair, blackboard and table, as well as some accessories such as the wastepaper basket or clothes rack; the *students' area* includes the conventional desks, certain security facilities (emergency lights, fire extinguishers) and space conditioning (heating, lighting). The authors afterward apply a theory-based classification system to categorize student perception of some environmental features relevant to classroom quality (psychological quality). Three dimensions were found: *evaluation*, which includes appearance, conditioning, changes made by the students themselves, and individual and group work facilities; *activation* includes some facets and arrangements for academic work, such as location of the classroom, interaction with classmates, and rest facilities; and *control*, which includes some distractors, such as noise, view from the windows or disturbing classmates. The three factors run parallel with the dimensions of environmental meaning described by Ward & Russell (1981) and Corraliza (1987).

According to the general paradigm of environmental evaluation (Craik & Feimer, 1987; Fernández-Ramírez & Rebolloso, 2002), evaluation criteria may be weighted using different empirical and statistical procedures; for instance, studying the opinion of a panel of experts and users about the relevance of criteria, or defining an external referent (e.g., classroom satisfaction, academic results), and analyzing a large enough number of classrooms using multivariate statistical methods. Using a combination of both procedures, Rebolloso et al. (2002, p.54-55) conclude: *Well designed classrooms combine certain aesthetic values and basic conditions (temperature, lighting, conditioning). They are also suitable for academic work (individual or group) and for breaks between classes, with the absence of distractors (noise, views) being especially relevant. Finally, given the repetitive image of the student area in most classrooms, the existence and arrangement of furniture in the teacher's area play an important role in classroom satisfaction*.

Previous research coincides in similar results, as classroom quality is related to legibility, absence of sinergetic conflicts (stimulation, noises, visual privacy), and several environmental conditioning elements (Schneider, 2002), with conventional design being more adequate for complex tasks (Ahrentzen & Evans, 1984; Gump, 1987; Stone, 2001). The importance of conditioning elements is documented elsewhere. Maxwell (2003) analyzes the effect of spatial density (amount of space for child) as a predictor of lower performance. Douglas & Gifford (2001) find that physical properties (view to outdoors, seating comfort, seating arrangement) explain a great part of classroom evaluation by students and teachers.

Beyond spatial explanations, it also has to be realized that students are not passive observers, but actors in the classroom scene. They must display territorial or space appropriation behavior to develop an environmental identity (Killeen, Evans & Danko, 2003; Pol, 1996; Proshansky, Fabian & Kaminoff, 1983) through changes they themselves make to enhance their environmental conditions. For instance, they may change their position in the classroom, personalize the space or create new uses for the furniture to fit with their needs.

Finally, Rebolloso et al. (2002) found a relationship between technical and psychological measures of quality, with the latter being a more powerful explanation for classroom satisfaction. Furthermore, they suggest a mediating sociophysical process, posing that *technical conditions have an indirect relationship with satisfaction or perceived* *environmental quality through subjective evaluation* (p.56-57). Therefore, environmental quality research benefits from a combination of both methods of measurement, rejecting the conceptual problem and reducing the controversy.

NGT and diagnostic evaluation

Diagnostic evaluation has usually been the initial stage in systematic models of social intervention since Lewin's action-research approach (Lewin, 1946). Relevance of the diagnostic for analysis of the extent and seriousness of social problems as targets for intervention is recognized in many evaluation models (Rossi, Lipsey & Freeman, 2004; Stufflebeam, 2000). Researchers also take this perspective in the study of environmental design, with a first context evaluation stage integrated in the systematic process of environmental intervention and evaluation (Cherulnik, 1993; Fernández-Ramírez & Rebolloso, 2002; Zeisel, 1981; Zube, 1980).

Diagnosis is a complex task, which includes a broad set of activities, such as identifying needs, problems, and opportunities for enhancement, and so on (Rossi et al., 2004). Diagnostic results become the central element and the organizer of intervention, helping to structure the remaining stages in the policy and evaluation process. This is the reason why the stakeholders' opinions and values must be analyzed, assuring that intervention solves real and specific social problems, and is not simply part of political agendas or academic interests.

Very different methods may be used for diagnostic evaluation, even if the quantitative and qualitative combination is accepted as valid, for instance, observation, economic analysis, or critical analysis of norms, rules and the legislative framework. Interviews and group analysis (focus group, delphi, nominal group, etc.) gather direct information about problems and their causes as expressed by the persons affected. The use of questionnaires and attitude scales is justified, only when the main problem is well known, and well-tried theoretical or empirical models are available. Rebolloso et al. (2002) used theory-based questionnaires for analysing the students' perception of classroom environmental quality. The method was considered as successful in gathering data efficiently, interviewing large samples of students with a low effort demand. Problems were related to the excesive extension of the process of research, and the intrusiveness of researchers through the definition of the environmental questions to be discoursed.

The Nominal Group Technique (NGT) was created by DelBecq, van de Ven & Gustafson (1975) as a useful method for planning social policies and programs. The main objective is to focus the diagnosis on the opinions and values of relevant social players, avoiding the interference of the researcher's theoretical frame. NGT is a very structured group technique designed to gather qualitative information, quantified thereafter in evaluative terms by the respondents themselves.

In contrast with focus groups, NGT proceeds with participation by rigorous turn, limiting free interaction and controlling emergent processes of social influence (e.g., normalization, polarization, leadership). NGT has some clear advantages, because researcher participation is reduced, and information is gathered directly in the participant's own terms. In addition, results are considered as a group product, because the goal of the technique is to reach a consensus on the problems and opinions of the group as a whole. Hegedus & Rasmussen (1986) found that NGT enhances social interaction, increases the participant's satisfaction with the task, and is the most effective for problem solving. NGT is even more useful in finding the analytical components of a problem if the topic of discussion may be divided in small parts.

To avoid group influence on individual opinions, participants express them separately by turn. On valuing scores, DelBecq et al. (1975) suggest that group members also judge separately in mathematical terms, using rank-ordering or rating procedures, and calculating the mean average to assure that results express the true group preferences. Rating is recommended when there is a large number of items, participants are competent to make fine distinctions, and quantified differences among priorities are to be estimated. Notwithstanding, group influences may emerge when participants are sophisticated and tend to coaligate themselves to overestimate some items. Gallagher, Hares, Spencer et al. (1993) suggest standardized percentage scores to give a proper value to differences among items. Anyway, the final product is a set of group ideas, the consensual result of a structured discussion where everyone has had the same opportunities to offer his/her opinions.

Objectives

The first goal of the study is to analyze the student's direct perception of classroom quality to determine the main environmental design and conditioning problems, and gather suggestions for possible solutions. The intention is to emerge the students' implicit theory about classroom quality, and frame it by previous empirical and theoretical research. We are also specially interested in NGT as a diagnostic procedure for environmental design and evaluation, exploring its internal validity, or how data should be gathered and treated with sufficiently valid and rigorous analytical methods.

Method

Sample

71 second cycle students participated in the study (56.1% women, 43.9% men), distributed in 14 groups of five to six members (one group had only three) aged 19 to 26. Similar percentages of all the groups were from four colleges of the University (four belonged to the College of Humanities and Education, four to Experimental Sciences, four to Economics, and two to Law).

Behavior settings

The University of Almería (Spain) has 93 classrooms, most of them located in three independent buildings built since 1991 and enlarged just before the study. Though some classrooms are in departmental buildings, their design, conditioning, and furniture are the same. All of them are conventional row-per-column classrooms with rigid desks. 47.6% are 100 to 150 m^2 (39.7% are smaller, 12.7% are larger), and have an average seating capacity of 109 students (40 to 240 seats). Classrooms looks like any conventional classroom found in Spanish higher education institutions, with conventional illumination and climate systems, resources for slides projection. The teacher area is equipped with the usual furniture (table, chair, blackboard, slides projector). The students area is equipped with rigid desks and clothes racks. Each one of the fourteen groups discussed and valued the problems of their own classrooms, in order to enhance the ecological validity of the study. All the classrooms have similar setting and conditioning characteristics with no relevant variations from the general design described above.

Procedure

Data were gathered in Spring of 2001, five months after the term (the academic year is eight months long) had begun. Students are in a different classroom every year, so their experience with the classrooms under evaluation was limited to this period. A team of interviewers trained in NGT followed the same instructions on task stages, place, and conditions. The duration was 20 to 60 minutes, with the only problem of a generalized expression of tedium at stage four. Research questions were discussed previously by the research team. Clarity, directness, and lack of ambiguity were the criteria for selection. All the groups repeated the task to answer both research questions: *What environmental classroom problems are there?* and *What possible solutions do these problems have?* Participants valued their final answers by two procedures, assigning independent scores on a ten-point scale (*rating*), or placing them in ascending order of relevance (*rank-ordering*). Six groups of participants scored only by rating, and eight scored only by rank-ordering.

NGT was carried out in six stages:

1. Beginning of the meeting. The task objectives and stages are briefly described (duration, rules of intervention, interviewers' role, use of results). Participants must understand and accept the strong rigid structure of the task.
2. Silent individual production of ideas. Participants receive a card with the first question, and are given five minutes for silent individual reflection, generating and writing down their ideas (e.g., classroom environmental problems).
3. Presentation to the group. The ideas that have emerged are read aloud. Each participant reads just one idea in any given round, with as many rounds as needed. New ideas that emerge during this stage are also mentioned. Every participant must have the same opportunity to talk, and ideas are collected on a blackboard in their own words.
4. Organized discussion. Every idea is briefly discussed, listing favourable and unfavourable comments. Participants must ask for

clarification when they perceive ambiguities or mistakes, and their ideas may change as a consequence. The objective is not the discussion in itself, but the development of arguments for acceptance or rejection.

5. Individual evaluation of ideas. Participants have a few minutes to write down and score the ideas they consider the most relevant (rating or rank-ordering). Silent rating tries to reduce group influences. Scores are then read, and written down on the blackboard by the interviewers. The goal is to reach a numerical consensus about the relevance of problems.
6. Discussion of the results of evaluation (with possible modification). Results are discussed when participants so require, returning to stage three to clarify ideas, followed by private rating, and reading aloud of scores.

It is important to realize that the whole group is the subject of the interview. Final data is the product of a discussion in which individual opinions are diluted in the consensual group opinion. Therefore, behavior settings are the unit of analysis (and not persons), resolving the problems derived from the different composition of groups (Craik & Feimer, 1987; Gump, 1987).

Analysis

An *ad hoc* classification system was elaborated, based on the criteria of environmental quality used by Rebolloso et al. (1998, 2002). New categories were added as needed, according to some general recommendations (a minimum number of data in the category, descriptive power, theoretical basis, and so on). Inter-judge reliability was sufficient, with *kappa* between .84 and .90 for the whole system (three judges). The system would be described later.

After coding, problems and solutions mentioned by the fourteen nominal groups were transformed and summarized in a single table of results using four descriptive and two evaluative kinds of data: a) the descriptive were the total number of cases (problems or solutions) mentioned in each category, the percentage of cases, the total number of different cases after discarding redundancies and repetitions, and the percentage of different cases in each category; b) the evaluative were the mean averages of rating and rank-ordering scores in each environmental category.

Comparisons among data were made by multidimensional scaling (ALSCAL) and non parametric tests, in an attempt to prove whether different kinds of transformed data may be considered equivalent. To sum up the results, only the figures and values of fit are given here (*Kruskal-stress* measure, which must be less than 0.20 for n=20 and two dimensions; square multiple correlation, *RSQ*, indicating the percentage of variance explained by the model). The non-parametric *Wilcoxon* test is also used to prove the hypothesis that two related samples have the same distribution. These results are taken into account in deciding what data it is more advisable to use in analyzing the environmental categories. The classification system is then analyzed with the selected data. The internal structure is studied afterward through hierarchical cluster analysis (inter-group linkages, Euclidean square distances).

Results

On the application of NGT

A total of 183 problems and 124 solutions were found. Content analysis reduced them to 75 and 68 different problems and solutions. Figure 1 shows the results of problem analysis. Values of fit are good enough (*stress*=.16; *RSQ*=.867), with a two-axis solution. The total number of problems is plotted against the number of different problems on the abscissa. The data have a tendency towards the left side of the Figure, showing that the total number of problems is unrelated to the rest of descriptive and evaluative data. Therefore, reduced data seem to be more relevant in the explanation of results, and it is suggested that direct redundant NGT results be discarded. This effect is called the *redundancy bias*.

Both evaluating procedures (rating and rank-ordering) are plotted on the ordinate. The proximity between rank-order and the total number of problems (in percentages) is shown at the top of Figure 1, while the proximity between rating and the total number of different problems (in percentages) is shown at the bottom. In conclusion, the relative importance of a problem would depend on the frequency it is mentioned in rank-ordering. The sense of the evaluation would then be biased. This effect is called the *representation bias*.

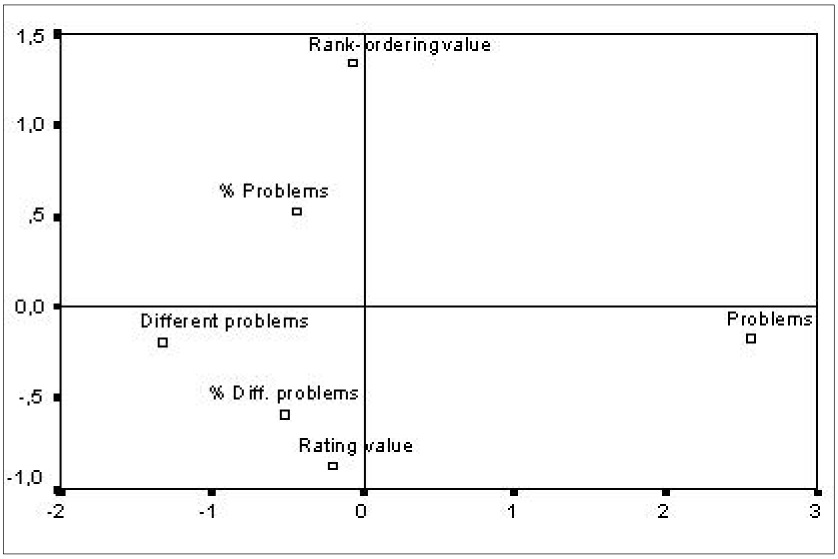

Figure 1. Distribution of different kind of data on environmental problems.

Both biases are replicated when the data about solutions to environmental problems are analysed (these analysis are not shown), and when descriptive data are compared by the *Wilcoxon* test. At the beginning, NGT groups produce a large number of answers, more than the number of real different problems and solutions ($z=-3.628$, $p<.001$; $z=-3.310$, $p=.001$). Notwithstanding, there are no intra-category differences when direct data are transformed into percentages ($z=-0.121$, $p=.904$; $z=-0.022$, $p=.983$), suggesting that percentages are valid for intra-category comparisons. On the representation bias, the rank-ordering value of an environmental category is related to the number of times the NGT groups mention the cases included in it. This result is found when both direct data (e.g., for environmental problems, $z=-0.483$, $p=.629$) and percentages are considered ($z=-0.362$, $p=.717$). In other words, as the frequency of mentions is increased, the possibility of assigning rank-order increases as well. Therefore, a rating procedure is preferred to rank-ordering.

Figure 2 shows a second multidimensional analysis. Descriptive and evaluative data on environmental problems and solutions are introduced together, excluding direct descriptive data in favor of their corresponding percentages (*stress*=.09; *RSQ*=.945). Once again, both evaluative procedures (abscissa), and descriptive data (ordinate) are plotted against each other in the MDS solution. The general suggestion is that different types of data seem to measure different questions.

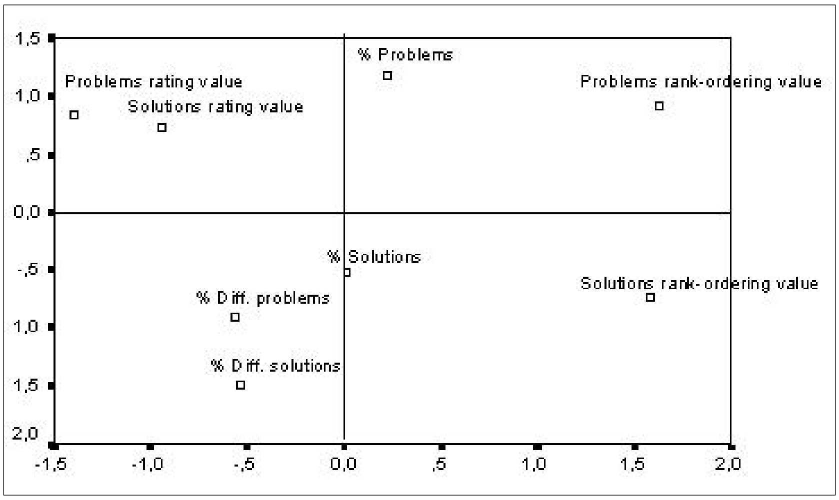

Figure 2. Distribution of different kind of data on environmental problems and their solutions

Interestingly, Figure 2 also shows the proximity of each specific kind of data on problems and solutions. The proximity of problems and solutions in the second MDS suggests also that NGT groups have a tendency toward similar answers when talking about environmental problems or solutions, regardless of whether data is descriptive (percentages) or evaluative (task redundancy effect). This effect may also be observed when data are analyzed by non-parametric methods (*Wilcoxon* test). For instance, in descriptive data there are significant differences between the total number of problems and solutions (z=-3.097, p=.002), though the difference disappears when data are transformed into percentages (z=-0.241, p=.809). The result is similar when the total number of different problems and solutions are compared, both analyzed with direct data (z=-

0.569; p=.569) and percentages (z=-0.040; p=.968). There are also non-significant differences between problems and solutions in evaluative data, with both rating (z=-0.283, p=.777) or rank-ordering scores (z=-0.719, p=.472), once again showing the *task redundancy effect*.

On the environmental categories

Some questions about the different types of data obtained by the NGT have just been analyzed in the previous section. Considering these results, the classrooms environmental problems and solutions will be analyzed now using only the relative percentages of the cases included in each category, together with the evaluation obtained by rating (see Table 1). To correctly read the table, consider that the data on each category is an aggregation of its respective subcategories results, adding them for calculating the categories percentages, and averaging for the categories rating values. In sum, the system is composed of eight environmental and one non-environmental categories of classroom environmental problems and solutions.

The first category includes items related to classroom location, both in terms of accessibility and proximity to other spaces: problems related to the difficulty of getting there from outside the building (e.g., *poor instructions*, *far from the bus stop*), and to the inadequate distance or location with regard to other spaces used daily (e.g., *far from other classrooms*, *too near the bathroom*).

The second category is divided into four subcategories related to the classroom conditioning: (a) lighting, or general conditions of interior illumination and visibility (e.g., *poor lighting*, *need for natural light*, *poor visibility*, *poor view because of columns*); (b) temperature, including specific problems with room temperature (e.g., *too hot*, *too cold in winter*), and existence of heating and air conditioning or maintenance problems (e.g., *no air conditioning*, *heating out of order*); (c) classroom ventilation (e.g., *no ventilation*); and (d) classroom size, including opinions about the size or the excessive number of students (e.g., *classrooms too big*, *overcrowding*).

The third category is about noise-related distractors. We distinguish between the appearance of unspecified noise or acoustic conditions derived from noise (e.g., *noise outside*, *poor soundproofing*), and some specific classroom noises (e.g., *doors and chairs make noise*).

Table 1. Classrooms environmental problems and solutions

Categories	Problems			Solutions	
	n	%	rating value	n	%
1. LOCATION	6	8.00	7.39	3	4.41
1.1. Accesibility	3	4.00	6.53	0	0.00
1.2. Proximity to other spaces	3	4.00	8.26	3	4.41
2. Conditioning	20	26.66	7.28	18	26.47
2.1. Lighting	7	9.33	7.37	7	10.29
2.2. Temperature	7	9.33	6.86	4	5.88
2.3. Ventilation	1	1.33	7.59	2	2.94
2.4. Classroom size	5	6.66	7.72	5	7.35
3. NOISE	9	12.00	5.90	6	8.82
3.1. Acoustics	6	8.00	6.66	4	5.88
3.2. Specific noises	3	4.00	5.15	2	2.94
4. ACTIVITIES. PAY ATENTION TO THE TEACHER	9	12.00	7.15	9	13.23
4.1. Difficulties in listening to the teacher	3	4.00	7.82	3	4.41
4.2. Seeing the blackboard	4	5.33	6.34	6	8.82
4.3. Seeing the projections	2	2.66	7.30	3	4.41
5. ACTIVITIES. PERSONAL WORK	11	14.66	7.08	9	13.23
5.1. Arrangement of desks	4	5.33	7.54	2	2.94
5.2. Personal space	3	4.00	6.90	2	2.94
5.3. Work space	3	4.00	6.06	2	2.94
5.4. Comfort of desks	1	1.33	7.82	3	4.41
6. ACCESSORIES	9	12.00	5.52	9	13.23
7. APPEARANCE AND MAINTENANCE	3	4.00	5.20	4	5.88
8. OTHER ENVIRONMENTAL PROBLEMS	3	4.00	6.20	3	4.41
9. OTHER NON-ENVIRONMENTAL PROBLEMS	5	6.66	7.60	7	10.29

The next two categories include problems related to classroom activities, differentiating between the general problems of paying attention to the teacher, and doing personal work. Category number four covers from difficulties in listening to the teacher (e.g., *teacher cannot be heard at the back of the classroom*, *poor acoustics in the back row*, *new microphones are needed*, *no amplifiers*), to clearly seeing the blackboard (e.g., *blackboard reflects light*, *classrooms are too big to see the blackboard*), and seeing transparencies projected (e.g., *can't see the projection*, *bad view of transparencies*).

Problems with personal work are directly related to desk design in the fifth environmental category. There are four subcategories: (a) poor arrangement, including comments on the distance between chairs and tables, or the arrangement of desks in the classroom space (e.g., *chairs separated from tables*, *poor arrangement of desks*); (b) problems with personal space, and of limited space (e.g., *hard to get up from the desk*, *classmates too close together*); (c) problems with work space, such as uncomfortable desks for the immediate classroom activities (e.g., *tables too small*, *too inclined*); and (d) some observations about the comfort of desks not included in any previous category (e.g., *uncomfortable chairs*).

The sixth category is related to the absence or poor arrange of furniture and other classroom accessories (e.g., *not prepared for the handicapped*, *no wastepaper baskets*, *too few computers*). The seventh includes comments on classroom appearance and maintenance (e.g., *scant decoration*, *cheap*, *badly cleaned*). Finally, the system is composed of two nonspecific categories: other environmental problems not included in any other previous category (e.g., *deficient classroom design*, *some classrooms have leaks*), and other non-environmental problems not clearly with the scope of this study (e.g., *ineffective practice activities*, *lack of friendship and sociability*, *lack of classroom security*).

The average value of the nine categories rating score is 6.59 (s.d. = 0.89). Just the category of non environmental problems scores more than one standard deviation above the average. This result indicates the narrow similarity among urgency or relevance in all the environmental problems, but in the categories six (accessories) and seven (appearance and maintenance), scoring less than one standard deviation below the average. Therefore, localization, conditioning, and task-oriented environmental facets are the most relevant evaluative questions in classroom quality.

Undoubtedly, there are relationships among categories and subcategories, and it is not easy to separate different problems that involve each other (e.g., classroom size, crowding, noise, difficulties in paying attention, personal space problems). The following cluster analysis attempts to understand the internal structure of the classification system (Figure 3), understood as an evaluation theory about classroom environmental quality. Distances are calculated using the three kinds of data considered appropriate in the section above: the total number of different problems and solutions (in percentages), and evaluation of problems by rating. All the subcategories have been included to fine tune the system. The last two nonspecific categories are excluded to keep an ecological perspective for the environmental evaluation of classroom design.

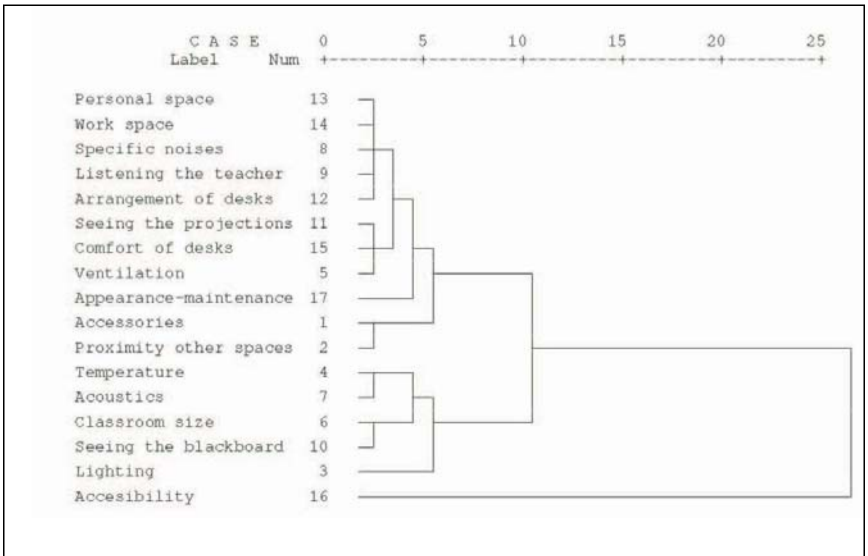

Figure 3. Cluster analysis of the environmental categories and subcategories

There seem to be two clusters. The first is composed of eight kinds of problems dealing with the student's immediate space (*desk cluster*), including difficulties for personal work (desk position and arrangement, discomfort, and noise and inconvenience in sitting down or getting up from desk), and paying attention to the teacher (difficulties in hearing or viewing the projection); the second is composed of five categories involving the student's far space (*classroom cluster*), which show some environmental problems affecting the space as a whole (temperature, acoustics, classroom size, lighting, view of the blackboard). However, the categories of appearance and accessories, so as the facets related to classroom localization, remain outside of the clusters, and don't clearly fit into the suggested structural model.

Discussion

The Nominal Group Technique (NGT) has proved useful enough for diagnosing environmental quality by identifying a large and diversified number of problems and solutions. This study has also shown some effects and biases implied in different kinds of NGT data. Three MDS and non-parametric analysis reinforced the conclusion about the NGT data preferred in a context of problem analysis and evaluation. Figure 2, for instance, showed a geometrical bidimensional space defined by the counterposition among four different kind of data used in the study (frequency, percentage, rating, rank-ordering). The difference does not seem to depend of content, but on the kind of data by themselves.

The *redundancy bias* with regard to the total number of group answers was found at first, compared to the real number resulting once repetitions had been removed. The bias was solved by discarding redundant items and standardization to percentages. A second *representation bias* was related to the confusion between problem urgency and frequency of mention. Rank ordering results were related to the total amount of problems mentioned. Therefore, the advisability of using an evaluation method independent of the number of mentions (e.g., rating) was suggested. Finally, the results of group discussion about environmental problems and solutions fit in different indexes, suggesting a reduction of discussions to only one evaluation question (reducing the *task redundancy effect*). All these results are coherent with the suggestions of DelBecq et al. (1975), and Gallagher et al. (1993), for working with NGT data.

A comparison with the study by Rebolloso et al. (2002) can also highlight some conclusions about the value of NGT in environmental social research. Our impressions of the process suggest that NGT requires a greater effort than questionnaires, but fewer participants. The problem of tedium during the task can be reduced by limiting the number of questions analyzed by the group, though the scope of the research must also be more limited than in questionnaire techniques. NGT is more useful from a qualitative perspective, because participant discussion can be acquired directly without interference by the researcher. The quantification of results also avoids possible interference, because it is decided by the participants themselves. Finally, NGT is more efficient because similar results are obtained with fewer participants in a faster data acquisition process.

Some authors have empirically proven the benefits of NGT over other group techniqes (Hegedus & Rasmussen, 1986), though future research must compare NGT with quantitative techniques (e.g., questionnaire) or other external criteria to also enhance its external validity. In our case, it is assumed that as the internal validity of NGT is enhanced, it may be reasonably used in contexts of applied social research, environmental evaluation and problem solving. Future research should go beyond to identify and guarantee the external validity of NGT data in the context of environmental diagnostic evaluation. Cherulnik (1993), for example, used the fit with environmental theories as a criterium for supporting the validity of design analysis.

The category of problems most mentioned is classroom conditioning (mainly lighting, temperature, and size). Other categories with high percentages are personal work, noise, paying attention to the teacher, and classroom accessories. This result is similar to the solutions for classroom problems, in which conditioning has the highest percentage (mainly lighting solutions). Other important categories are solutions for difficulties in paying attention to the teacher (blackboard visible), personal work, and classroom accessories.

Localization, conditioning elements and task-oriented facets are the main evaluative questions in classroom quality. This conclusion is broadly confirmed by previous research (Douglas & Gifford, 2001; Schneider, 2002). Rebolloso et al. (2002) also found a similar result when using an external criterion of value (classroom satisfaction) to determine the relative relevance of different criteria of environmental quality. However, all the problems were mentioned in a context of idea generation, and all of them received high scores.

Classroom environmental problems may be understood as a question of synergy, in which structural features (design, disposition, distances) explain most of the problems. The suggestion is that students perceive the classroom from the perspective of a behavior setting, with environmental problems being directly related to difficulties in carrying on with the internal program of activities (Gump, 1987). Previous results on environmental facets as spatial density (Maxwell, 2003), seating arrangements (Douglas & Gifford, 2001) or conditioning elements (Schneider, 2002) correctly fit also with this ecological perspective, giving sense to the contrasted relation between conventional classrooms and complex educational tasks (Gump, 1987; Stone, 2001).

The results of cluster analysis also suggested a structural ecological model or dimension of close *vs* distant space (micro vs. macro) with two levels: the desk, and the classroom. Students would analyze environmental problems from their position inside it, emphasizing the space around the body as a point of reference. Tversky (2003, p.69) has given it a functional meaning as *the space that can be seen and often reached from the current position*. Rebolloso et al. (2002) proposed a different ecological perspective of classroom environmental quality (teacher area *vs* student area), that should be integrated into this new close-distant dimension. Furthermore, the categories of localization, appearance, and accessories remained outside of the clusters, and don't clearly fit into the suggested structural model. More research is needed along this line. The goal of the study was not to develop such a model, but the system of categories. Therefore, this ecological model remains unexplored. The classical ecological psychology perspective, with its space-anchored description of behavior, may be a promising basis for future research.

While an ecological viewpoint may be useful, other theoretical perspectives may also be relevant for understanding the psychological experience of the classroom. Our results do not reject either that students have meaningful and affective experiences (Corraliza, 1987), nor that they are involved in power relationships with peers (classmates) and non peers (teachers) (MacPherson, 1984). However, the study has not found these questions to be relevant problems from the students' point of view.

With a different evaluation instrument, Rebolloso et al. (2002) found that student attitudes (classroom satisfaction) are better explained by applying the theoretical approach of environmental meaning (Corraliza, 1987; Russell & Snodgrass, 1987). Therefore, different instruments appear to be useful in analyzing different features of classroom experience, keeping in mind that each instrument requires a different theoretical approach. The method used in this study shows less sensitivity for questions of attitude. This may explain why classroom appearance is not highly relevant as an environmental problem.

This study was limited to an analysis of the components of classroom environmental quality that emerged as issues within the context of the NGT task. Therefore, the classification system used in it should not be considered as a complete model. This is both an advantage and disadvantage of NGT as a research strategy. It does not look for holistic visions of the object under study, but consciously reduces the focus toward a set of specific features. In this sense, NGT is a powerful analytical tool for breaking the object down into parts, and differentiating specific problems in diagnostic evaluation (Hegedus & Rasmussen, 1986).

The reduced number of participants introduces a problem of generalization, however balanced by the widely extended use of the conventional classroom model and the overall coincidence with results of previous research, so the comparability of these results with future studies at universities in other geographical areas is assured.

References

Ahrentzen, S., & Evans, G.W. (1984). Distraction, privacy, and classroom design. *Environment and Behavior*, *16*(4), 437-454.

Bell, P.A., Fisher, J.D., Baum, A., & Greene, T.E. (1990). *Environmental psychology.* Fort Worth, TX: Holt, Rinehart & Winston.

Cherulnik, P.D. (1993). *Applications of environment-behavior research: Case studies and analysis*. New York: Cambridge University Press.

Cohen, S., & Trostle, S.L. (1990). Young children's preferences for school-related physical- environmental settings characteristics. *Environment and Behavior*, *22*(6), 753-766.

Corraliza, J.A. (1987). *La experiencia del ambiente. Percepción y significado del medio construido*. Madrid, Spain: Tecnos.

Cotterell, J.L. (1984). Effects of school architectural design on student and teacher anxiety. *Environment and Behavior, 16*(4), 455-479

Craik, K.H., & Feimer, N.R. (1987). Environmental assessment. In D. Stokols & I. Altman (Eds.), *Handbook of environmental psychology* (pp. 891-918). New York: Wiley.

DelBecq, A.L., van de Ven, A.H., & Gustafson, D.H. (1975). *Group techniques for program planning. A guide to nominal group and delphi processes*. Glenview, IL: Scott, Foresman & Co.

Douglas, D., & Gifford, R. (2001). Evaluation of the physical classroom by students and professors: a lens model approach. *Educational Research*, *43*(3), 95-309.

Fernández-Ramírez, B., & Rebolloso, E. (2002). Fundamentos para un modelo de evaluación ambiental. In R. García-Mira, J.M. Sabucedo & J. Romay, Eds., *Psicología y medio ambiente. Aspectos psicosociales, educativos y metodológicos*, A Coruña, Spain: Asociación Galega de Estudios e Investigación Psicosocial, pp 333-358.

Gallagher, M., Hares, T., Spencer, J., Bradshaw, C., & Webb, I. (1993). The Nominal Group Technique: A research tool for general practice? *Familiy Practice*, *10*(1), 76-81.

Gifford, R. (2002). *Environmental Psychology: Principles and practice*. Colville, WA: Optimal Books.

Gump, P.V. (1987). School and classroom environments. In D. Stokols & I. Altman (Eds.), *Handbook of environmental psychology* (pp. 691-732). New York: Wiley.

Hegedus, D.M., & Rasmussen, R.V. (1986). Task effectiveness and interaction process of a modified Nominal Group Technique in solving an evaluation problem. *Journal of Management*, *12*(4), 545-560.

Killeen, J.P., Evans, G.W., & Danko, S. (2003). The role of permanent student artwork in students' sense of ownership in a elementary school. *Environment and Behavior*, *35*(2), 250-263.

Küller, R., & Lindsten, C. (1992). Health and behavior of children in classrooms with and without windows. *Journal of Environmental Psychology*, *12*(3), 305-317.

Lewin, K. (1946). Action-research and minority problems. *Human Relations*, *1*, 34-46.

MacPherson, J.C. (1984). Environments and interaction in row-and-column classrooms. *Environment and Behavior*, *16*(4), 481-502.

Maxwell, L.E. (2003). Home and School Density Effects on Elementary School Children. *Environment and Behavior*, *35*(4), 566-578.

Pol, E. (1996). La apropiación del espacio. In L. Íñiguez & E. Pol, Coords., *Cognición, representación y apropiación del espacio* (pp. 45-62). Barcelona, Spain: Publicacions de la Universitat de Barcelona.

Proshansky, H.M., Fabian, H.A., & Kaminoff, R. (1983). Place-identity: Physical world socialization of the self. *Journal of Environmental Psychology*, *3*(1), 57-83.

Rebolloso, E., Fernández-Ramírez, B. Pozo, C., Hernández, S., & Peñín, R. (1998). La evaluación ambiental de las aulas en los entornos educativos superiores. In J.M. Sabucedo, R. García-Mira, E. Ares & D. Prada, Dirs., *Medio Ambiente y responsabilidad humana. Aspectos sociales y ecológicos* (pp. 499-506). A Coruña, Spain: Tórculo,.

Rebolloso, E., Fernández-Ramírez, B., & Cantón, P. (2002). Criterios de calidad ambiental para la evaluación de aulas universitarias. *Medio Ambiente y Comportamiento Humano*, *3*(1), 35-62.

Rossi, P.H., Lipsey, M.W., & Freeman, H.E. (2004). *Evaluation. A systematic approach*. Thousand Oaks, CA: Sage.

Russell, J.A., & Snodgrass, J. (1987). Emotion and the environment. In D. Stokols & I. Altman (Eds.), *Handbook of Environmental Psychology* (pp. 245-280). New York: Wiley.

Schneider, M. (2002). *Public School facilities and teaching: Washington, D.C., and Chicago*. Retrieved August 14, 2007, from NCEF, National Clearinghouse for Educational Facilities. Web site:

http://www.21csf.org/csf-home/Documents/Teacher_Survey/SCHOOL_FACS_AND_TEACHING.pdf

Scriven, M. (1995). The logic of evaluation and evaluation practice. *New Directions for Evaluation*, *68*, 49-70.

Stokols, D. (1978). Environmental psychology. *Annual Review of Psychology*, *29*, 253-295.

Stone, N.J. (2001). Designing effective study environments. *Journal of Environmental Psychology*, *21*(2), 179-190.

Stufflebeam, D.L. (2000). Evaluation models. *New Directions for Evaluation*, *89*, 7-97.

Tversky, B. (2003). Structures of mental spaces: how people think about space. *Environment and Behavior*, *35*(1), 66-80.

Ward, L.M., & Russell, J.A. (1981). The psychological representation of molar physical environments. *Journal of Experimental Psychology: General*, *110*, 121-151.

Wong, C.Y., Sommer, R., & Cook, E.J. (1992). The soft classroom 17 years after. *Journal of Environmental Psychology*, *12*(3), 337-343.

Zeisel, J. (1981). *Inquiry by design: tools for environment-behavior research.* Monterey, CA: Brooks/Cole.

Zube, E.H. (1980). *Environmental evaluation: Perception and public policy*. Cambridge: Cambridge University Press.