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Understanding Teachers' Evaluation Criteria: A Condition for Success in Science Classes

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Abstract

This study is part of a broader research project. The main aim was to find out pedagogic practices which can improve students' science achievement, namely, in complex cognitive competencies. The study is based on Bernstein's theory. Previous studies have suggested that the explicitness of the criteria of evaluation is related to students' scientific understanding and achievement. One of the many ways in which the evaluation criteria can be made explicit to students is through assessment tests, and their correction and marking. In this study, we analyze the extent to which students understand teachers' evaluation criteria, more specifically, teachers' marking criteria and procedures (i.e., the extent to which they have recognition and realization rules to the assessing context). We also analyze the relation of that understanding with social class, social context of the school, teacher's conceptual demand, teachers' explicitness of criteria, and science achievement. A clear relation between students' acquisition of recognition and realization rules and social class is shown: the higher the social class, the higher that acquisition. A privileged school's social context and the teacher's explicitness of assessing criteria also contribute to students' understanding of teachers' evaluation criteria. This understanding influences science achievement, especially in complex competencies.

This study is part of the ESSA Project—Sociological Studies of the Classroom—whose main aim is to find pedagogic practices which, without lowering the level of conceptual demand, can contribute to the improvement of students' school achievement, namely, the achievement of disadvantaged social groups. The theoretical framework is found in sociologic theories, such as Bernstein's theory of pedagogic discourse (Bernstein, 1977, 1990; Domingos, Barradas, Neves, & Rainha, 1986).

Previous studies (Morais, Fontinhas, & Neves, 1992; Morais, Peneda, & Medeiros, 1993; Morais & Antunes, 1994; Morais & Nunes, 1994; Ferreira & Morais, in press) suggested that the explicitness of the criteria of evaluation is related to students' scientific understanding and achievement. This means that the stronger the framing (degree of control of students on their

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acquisition) in the evaluation criteria, the less implicit these criteria are, and the easier the student will produce the text legitimized by the school. This production entails the possession of two basic rules: recognition rules to distinguish the specificity of a given context and realization rules to select and produce the appropriate text to that context. That is, it entails the possession of the specific coding orientation to a given context.

One of the many ways in which the evaluation criteria can be made explicit to students is through assessment tests, and their correction and marking. This study focuses on this subject and addresses the following questions:

- Do students understand teachers' evaluation criteria? More specifically, do students understand teachers' marking criteria and procedures?
- Which students better understand teachers' evaluation criteria? Are there any relations between their understanding and social class, social context of the school, teachers' conceptual demand, and teachers' explicitness of criteria?
- Does students' understanding of teachers' marking criteria and procedures influence their science achievement?

We assumed that all teachers correct and mark students' tests according to some criteria, which may or may not be made clear to the students. If they are made clear, then the students will have access to the principles of correction held by the teacher, and in that case, it will be easier for students to learn what is missing in the answers they give. It will be easier to know the legitimate text they should produce.

If students have the recognition rules for the assessment context, then they can recognize that answers are to be separated as correct and incorrect, according to a principle of correctness and incorrectness. If they have the realization rules, then they are able to attribute a correct mark (according to teachers' criteria) to the answer given by another student and use the same system of notations and informations, to indicate the correctness or incorrectness of the answer, as the system used by the teacher. The degree of reproduction, by the student, of a teacher's criteria gives a measure of his or her possession of the recognition and realization rules for the assessing context.

We therefore wanted to find out the extent to which students had a specific coding orientation (recognition and realization rules) to the assessing context. We started from some hypotheses which directed the research:

- Middle-class students have, to a higher degree, a specific coding orientation (recognition and realization rules) to the assessing context compared to working-class students.
- Within the working class, students from urban schools have a specific coding orientation to a higher degree than do students from rural schools.
- Teachers' explicitness of evaluation criteria contributes to the possession of the specific coding orientation.
- Teachers' higher conceptual demand makes the acquisition of the specific coding orientation more difficult especially when evaluation criteria are not explicated.
- The possession of the specific coding orientation is related to science achievement, namely, in the complex cognitive competencies.

The expression *social context* is used to indicate the area and the type of the school. We started from the idea that schools placed in different cultural and socioeconomic contexts reproduce differentiated organizational structures and forms of communication which are reflected in the classroom.

We start by giving some theoretical guidelines, followed by a description of the sample and the methodology in which we give particular attention to the form of determining students' specific orientation (recognition and realization rules) to the assessment context. We then proceed with an analysis of the data, which is followed by interpretation and a conclusion. A detailed description of the study can be found in Miranda (1993).

Theoretical Framework

The understanding of differential achievement in science requires the analysis of the specific pedagogic discourse as a set of rules which regulate the transmission and acquisition of scientific knowledge. The pedagogic discourse refers not only to the scientific contents and competencies to be transmitted but also to their transmission and evaluation. It refers to *what* is transmitted, *how* it is transmitted, and also which students' realizations are considered legitimate.

Bernstein's theory establishes that the pedagogic discourse is made up of two discourses, the regulative and the instructional (Bernstein, 1990). Regulative discourse (RD) is a discourse of *order* which translates the dominant values of society and regulates the form of *how* knowledge is transmitted; instructional discourse (ID) is a discourse of *competence* which refers to *what* is transmitted. The two discourses are incorporated in a way so that the RD always dominates ID.

Pedagogic discourse is transmitted through a specific code which integrates specialized contexts (e.g., science classroom contexts) and the selection and production of appropriate texts to these contexts. Any textual production in a given context depends on the acquisition of the specific coding orientation to that context. This means that the subject should have acquired the recognition rules (i.e., he or she should be able to recognize the context) and also the realization rules to produce the respective legitimate text. Realization rules are principles which contain two dimensions: the selection of meanings and the respective textual production. In other words, to produce the legitimate text, the subject should be able to select the relevant meanings and produce the text according to those meanings.

In the evaluation context, the answers to tests are, in general, an especially relevant act. Although specific modalities of pedagogic practice may introduce variations in the degree of importance attributed to tests relative to other students' evaluation elements, they keep being—either for transmitters or acquirers—a privileged communication means for the transmission and acquisition of the evaluation criteria. As Bernstein (1990) said, there are criteria which the student is expected to acquire and apply to his or her own practices and to others'. Criteria make the acquirer capable of understanding what is considered to be a communication, a social relation, and a legitimate or illegitimate position. We can therefore admit that because the understanding of the evaluation criteria contributes to the production of the legitimate text, acquisition is a factor which influences students' differential achievement.

The approach followed here, although focused on the instructional discourse, intends to relate both dimensions of the pedagogic discourse. In the analysis, we used the concept of framing which refers to the form of social control between different categories. In the relation of teacher and students, framing refers to the control on the discursive rules (selection, sequence, pacing, and evaluation criteria) which regulate the transmission of knowledges and competencies, and also to the hierarchic rules which regulate the norms of social conduct between transmitters and acquirers. Thus, framing can be weaker or stronger at the levels of both ID and RD.

At the microinteractional level of the classroom, the transmission and reproduction of the pedagogic discourse is realized through a given pedagogic practice. In the context of the correction and marking of tests, the specific pedagogic text is made visible by the notations and information the teacher makes to the answers of the students and also by the marks given to

them. Those notations and informations can refer to either the ID or the RD. Knowledge, cognitive competencies, and scientific processes are the contents of the instructional discourse. Social dispositions, namely, attitudes and values, rules of conduct, and principles of social morality are the contents of RD. Thus, for example, if the teacher indicates that the answer is right, wrong, or incomplete, he or she refers directly to contexts of the ID, where the type of contents depends on the question to which the answer refers. But when the teacher writes "Answer equal to John's," "If you had paid attention in class your answer would have been right," "The work in group helped you to understand the subject," "You did not pay attention to my advice," "I can see you have studied," these observations refer to contents of the RD, because they appeal, respectively, to the value of honesty, rules of conduct, cooperation, obedience, and the duties of a student.

The RD may not be explicated as in the above examples, but this does not mean that it is not present. Let us exploit the relations between the two discourses in the assessing context, by analyzing a hypothetical situation. At the level of the ID, let us imagine different possible behaviors by the teacher when correcting an incomplete answer. The teacher may not make any notation; he or she may simply write "inc," or may give an indication of the scientific contents and competencies which are missing, or he or she may write in the text which is missing in the answer, to make it correct. In this example, the sequence we gave corresponds to an increasing explicitness of the evaluation criteria, which translates to an increase in the strength of the framing. We can therefore say that when the evaluation criteria are becoming more explicit, there is, at the level of instructional discourse, a grading from weak (E^-) to strong (E^+) framing. What is happening simultaneously with the RD? At the same time the teacher textual production expresses the evaluation criteria more clearly, he or she personalizes the transmission–acquisition process, taking into account the individual student he or she is addressing; the teacher gives the student instruments which the student can ultimately use to contest the mark (i.e., is weakening the framing in the hierarchical rules). Thus, at the same time that the criteria of evaluation are made more explicit in the correction and marking of tests, the teacher increases the framing at the level of the ID and decreases at the level of the RD. Figure 1 shows the interrelations between the framing values for the ID and the RD in the assessment context.

Using the example given before and considering it to be an indicator of the strength of framing in the teacher–student relation, we can associate with it a scale made up of four degrees, as shown in Figure 2. The strength of the framing increases from the first degree (F^{--}) to the fourth (F^{++}), with the two first degrees corresponding to weak framing and the two last to strong framing in the discursive rule evaluation criteria. On the contrary, the strength of the framing in the hierarchical rules (RD) decreases from the first degree (F^{++}) to the fourth (F^{--}).

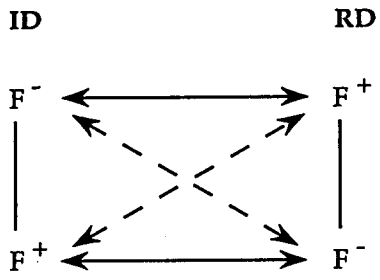


Figure 1. Relations between ID and RD in the assessment context.

INDICATOR	CONTROL RELATIONS FOR EVALUATION CRITERIA (ID)			
	F^{--}	F^{-}	F^{+}	F^{++}
Incomplete answer	Does not make any notation	Writes 'inc'	Gives an indication of the scientific contents/competencies which are missing	Indicates (writes) the text which is missing in the answer
	F^{++}	F^{+}	F^{-}	F^{--}
	CONTROL RELATIONS FOR HIERARCHICAL RULES (RD)			

Figure 2. Scale for framing relations of ID and RD in the assessment context: example for one indicator.

A teacher who behaves according to the first situation, does not make the criteria of evaluation explicit. As such, the teacher does not offer the student the possibility of learning the legitimate text and how to give a correct answer in the future. The message is therefore left implicit. The mode of control is imperative and positional; that is, framing is strong at the level of the RD (hierarchical rules). On the contrary, a teacher behaving according to the last situation explicates the text which is considered legitimate and, as such, gives to the student the possibility of self-evaluation and of giving a correct answer in the future. The message is explicit. In this case, the teacher uses a personal control; in other words, framing is weak at the level of the RD (hierarchical rules). The student acquires the means to discuss the mark accorded.

In the same way, whenever the teacher gives the value of each question to students before they answer the test, and whenever later on, when correcting and marking the test, he or she informs the student of the mark accorded again to each question, the teacher is making the evaluation criteria explicit (strong framing) on one hand, and using personal control in the hierarchical rules (weak framing), on the other.

Sample

A sample of 92 students of the 5th year of schooling (ages 10 to 11) was selected. The students were part of 4 school classes; 2 were from a school (Y) located in a town in the country, and 2 others from a school (X) located in a rural area in a village not far from the town. School Y had a socially heterogeneous population, and School X had a predominantly working-class population. The two classes of each school were taught by the same teacher (both women) in the subject of natural sciences. From this sample, a subsample of 33 students was selected. The criteria for this selection were the following: (a) students from School X were all part of the working class; (b) the same number of students of two main social groups (working and middle class) were in School Y; (c) the same number of working-class students were in both schools; (d) the same number of girls and boys were of each social class; (e) the same number of poor and good achievers were within each social group. Students of School X lived either in the village or in smaller villages nearby. Because in the global sample of School Y there were no middle-class boys with low achievement, this subgroup was excluded from the subsample. A final distribution of the sample for this study is given in Table 1.

Table 1
Distribution of the Sample According to School and Students' Social Class, Gender, and Achievement

School	Achievement	Social Class and Gender			
		WC		MC	
		G1	G2	G1	G2
School X	≥50%	3	3		
	<50%	3	3		
School Y	≥50%	3	3	3	3
	<50%	3	3	3	

Methodology

General Procedures

The study focused on the discipline of natural sciences. Students answered two school tests—one in each school—on the same teaching unit. Each teacher corrected and marked her students' tests. We considered students to have good achievement when the mark obtained was ≥50%, and to have poor achievement when that mark was <50%. This achievement refers, therefore, to the cognitive competencies (simple and complex) taken together. The achievement was also considered separately for simple and complex competencies. Teachers differed much in the emphasis they put on each one of the two types of competencies; for the teacher of School X the majority of the test questions evaluated simple cognitive competencies (74%), whereas for the teacher of School Y only half (48%) of the questions evaluated these competencies. This fact, by itself, would indicate a lower level of conceptual demand for the teacher of School X. This difference in the conceptual demand of the two teachers was confirmed by another study developed by Miranda and Morais (1995).

Data on students' social class were obtained through questionnaires answered by parents in an interview situation. Social class[1] was determined by four indices: father's and mother's academic qualifications and occupations. Each of these variables had a value from 1–4, according to the categories of the scales used. Because it was verified that, as in former studies, the four indicators of social class were highly correlated and that father's academic qualification (FAQ) was the indicator with higher correlation with science achievement, we considered FAQ to be the indicator of social class. We considered as working-class (WC) those fathers whose academic qualifications were in Levels 1 and 2 of the qualifications scale and as middle-class (MC) those fathers whose academic qualifications were in Levels 3 and 4. The two categories considered in terms of academic qualification (WC and MC) corresponded approximately, in our sample, to manual and nonmanual occupations, respectively.[2]

Recognition and realization rules in the assessing context were investigated by means of a semistructured interview with the students. In the first part of the interview, we inquired as to whether students could recognize the basic principle of the marking of answers: that is, if the students could distinguish between contexts by selecting the subcontexts of correct and incorrect. In the second part, we sought to determine whether students reproduced the text of their teacher when correcting and marking the tests.

In the first part of the interview, students were given three questions (of three levels of

complexity—factual knowledge, concept understanding, and concept application), one at a time, from a test they had answered in their science class. They were also given 10 answers (with different degrees of correctness) for each question and were asked to group them as they wished and to justify the groupings. The students demonstrated recognition rules if their groupings were made according to the principle correct/incorrect (independently of the answers being correct or incorrect).

In the second part of the interview, the three questions were given again, one at a time. With each question, the students were presented with one answer given by a classmate, and were informed that that answer had been considered correct by the teacher, and were told the mark it was accorded. They were also presented with five other answers given by other classmates (taken from 10 answers given before) and were asked to perform as their teacher to correct and mark the answers. The students would evidence realization rules if they attributed to the answer a similar mark to the one attributed by their teacher and if they used a similar system of notations and information.

Data on teachers' evaluation criteria were obtained through content analysis of the texts they produced when they corrected and marked the tests, and also by their respective matrices of tests' correction. We therefore assumed that teachers' evaluation criteria are usually better concretized in the correction and marking of tests.

Planning of the Instrument

The principles which orientate the conception of the instrument were common to the two schools. For the first stage, we selected 3 questions and 10 answers for each question. For the second stage, we kept the same questions; for each question, we selected 5 of the former 10 questions and also selected a 6th answer, which we designated *correct answer,* because the teacher had given it the whole value of the question. This answer would be the model answer which each teacher considered to be the legitimate text. Questions were designated Q-1, Q-2, and Q-3; the correct answer, A-1, A-2, and A-3; and the answers to each question, $A_1, \ldots A_5, \ldots A_{10}$.

Because we wanted to study the acquisition of recognition and realization rules in the context of questions of different levels of complexity, we considered the following criteria for the selection of the questions:

1. Questions would be of three types from the point of view of their form—one objective question (legend of a figure) and two essay questions. One of these was a short answer question in which the nature, length, and organization of the answer was short, and another was a free-answer question in which the students had greater freedom to organize the answer.
2. The three questions assessed competencies with different degrees of complexity: the first referred to acquisition of factual knowledge (simple cognitive competencies) and the second and the third to concept understanding and concept application, respectively (complex cognitive competencies).[3]

The general criterion upon which the selection of the answers was based was related to the requirement of text production. A pilot study had revealed that the differentiation of the answers was related to the form in which the questions were formulated. For example, multiple-choice or correspondence questions would result in correct answers by most students; that is, they would not discriminate between students. Further, we selected questions the majority of the students had answered, because this would give the possibility of considering them as represen-

tative answers on the one hand, and would give a greater possibility of answer selection on the other.

For the selection of answers we also established that each set of answers would be such that: (a) correct, incorrect, and incomplete answers were included so that they ranked over the whole range of marks given by the teacher; (b) the longest answers were not always the correct ones; (c) answers which had been crossed out and/or had spelling or syntax mistakes were included; and (d) a spectrum of answers which ranked over the symbolic language used by the teacher in the correction of students' text. Answers given by the students to be interviewed were not included among the options.

Test items and students' answers were photocopied on cards without introducing changes. For each set, the question and respective correct answer were given on two separate white cards, whereas answers to be handled by students were given on colored cards, each one separately. The instrument for each school (X and Y) was constructed with items of the test given to students of that school and answers given by students of the same school. However, both instruments had the same structure and the questions chosen adhered to the same criteria of selection. Questions were necessarily different because they were derived from two different tests.

Interview

The semistructured interview[4] had the following steps:

First Stage.

1. The student was given the first question and the set of 10 answers for that question. The interviewer stated: "Here is a question of the test made by your teacher and 10 answers given by some of your classmates to that question. Please group the answers as you wish."
2. The student was asked to indicate the answers of each of his or her groupings (through the notation A_1, A_2. . . .) and to explain the reason for that grouping.
3. Second and third questions and respective answers were presented, and for each one, procedures 1 and 2 were repeated.

Second Stage.

4. The student was given again the first question, the "correct answer" and respective value, and the set of five answers. The interviewer said, "You have here the first question you were given before, and this is a possible correct answer. You are going to take on the role of your science teacher, correcting and marking the tests. . . . These cards are for you only, so you can write whatever you wish on them. . . ."
5. The student was then asked to justify the mark he or she gave for each answer and to explain the meaning of the notations made.
6. Second and third questions and respective values were given, and for each one of them Procedure 4 and 5 were again followed.

Evaluation of the Texts

One of the objectives of the study was to compare the acquisition of the recognition and realization rules by students of the two schools. Test questions and selected answers were the

same for the students of the same school but differed between schools, because they were taken from the test developed by each teacher. While the teachers of the two schools shared the correctness/incorrectness of the answers as a principle of tests' correcting and marking, they differed in their notion of what was considered legitimate text and in the form they used to explicate that to the students. For these reasons; the analysis of the data involves two different types of procedures. When we investigate the acquisition of recognition rules, we interpreted the justifications given by all students of the sample according to the general principle of the answers' correctness and incorrectness. When we investigate the acquisition of the realization rules, the text produced by the students of each school is examined separately, using the evaluation criteria of each teacher as a reference. Thus, whereas in the first case there was a simultaneous analysis of all students, in the second case there were two parallel analyses corresponding to the students of the two schools.

Acquisition of Recognition Rules

In the evaluation context, students were assessed by the correction of their answers. The principle of classification of answers was, for any teacher, the degree of correctness. Through the analysis of the matrices of tests' marking available from teachers, it was possible to see that both gave marks which varied from zero to the maximum value in some answers and extreme marks of zero and the maximum value in some others.

When students were given a test question and various answers to that question and were asked to group those answers, the student had to distinguish between two contexts: evaluation from other classroom contexts; within the evaluation context, he or she had to select two subcontexts: correct or incorrect.

We then considered that students had recognition rules when they made groupings according to the principle of classification *correct/incorrect* (with or without intermediate degrees, such as their teachers), independently of the correction of the answers they chose as correct and of the incorrection of the answers they chose as incorrect. The analysis of the texts produced by students therefore focused on the finding of the principle of marking of the answers, through the justifications given to the groupings they made. A previous analysis of the data suggested the adoption of the methodology shown in Figure 3.

The evaluation of the answers to the "why" of group formation was a difficult task because of the students' difficulties of verbalization: namely, of the working-class students and, within them, those of School X. Although these data were obtained through a dialogue, the fact that we looked for an answer to an open question, Why did you group in this way? together with the preoccupation of not inducing students to the answer, led in some cases to less explicit answers. This was the case, for example, when the student did not answer or when he or she said, "I cannot explain better." This type of situation was reflected, naturally, in the analysis of the data. Being aware of the subjectivity inherent in the interpretation of students' answers to the questions of the interview, we made a detailed exam of the dialogues that occurred during the interview with the objective of minimizing that subjectivity. The examples which follow show the meaning attributed to students' sentences (I = interviewer; S = student).

Example 1: The Principle of Classification is Unclear.

I: Why did you group the answers in this way?
S: I think they looked right.
I: They looked right? What do you mean by that?

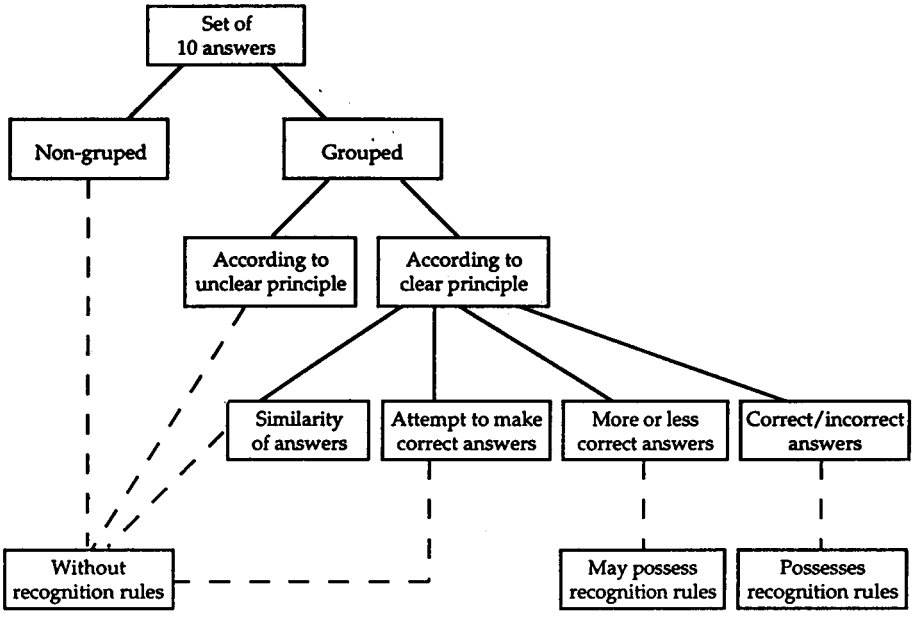


Figure 3. Diagram of the methodology followed in the analysis of data relative to the acquisition of recognition rules.

S: That the groupings seemed right . . .
I: Do try to explain better . . .
S: It was to be more or less equal to this here . . . the figures . . .

Example 2: The Student Groups According to the Degree of Similarity of the Answers.

First group: A_1 and A_6 because they are similar.
Second group: A_2 and A_{10}, because they are equal.
Third group: A_4, A_8, and A_7, because they tell the same thing.

Example 3: The Student Groups Trying to Make a Correct Answer by Joining the Answers of the Same Group.

S: In the first group, A_6, A_1, A_5, A_8, and A_9, because when I joined them together I get a complete [answer . . .] from the topsoil to the bedrock.

Example 4: The Student Groups According to the Degree of Correctness, without Incorrect Answers.

First group: A_9, A_6, and A_3: Here I think is where it is better.
Second group: A_5, A_7, and A_4: Here it is becoming a little worse.
Third group: A_1, A_2, A_{10}, and A_8: And here it is not so well.

Example 5: The Student Groups According to the Correct/Incorrect Criterion, with Intermediate Degrees.

First group: A_4, A_9, A_1, and A_3, because I think these are the ones which are right.
Second group: A_2 and A_6: These are also right, but for me the most right are these four (the answers of first group).
Third group: A_5, A_7, A_8, and A_{10}: These are what I think is not right.

From the interpretation of the texts produced by students, we made the system of categories presented in Table 2. This gave the possibility of analyzing, either separately or as a whole, the principle of classification underlying the constitution of groups.

The horizontal reading of the interview data (i.e., the analysis of the texts produced by all students for each item) showed that although the number of groups and their constitution varied among questions and among students, the range of criteria selected by all students was similar for all questions. For example, the justification, "I grouped the answers which were similar," independently of originating two or more groups with various combinations of answers for each question, occurred for any of the questions.

The vertical reading of the data (i.e., the analysis of the texts produced by each of the students in the three sets of answers) revealed that beyond the variations in the number and constitution of groups, about half of the students maintained the same criterion for the three questions, whereas other students showed that behavior for two questions (the first and the second or the second and the third) and only a few used one criterion for each of the questions.

Acquisition of Realization Rules

As we said before, the students were given three sets of five answers to three questions with different levels of complexity, and also a correct answer to each question. They were then asked to play the science teacher when the teacher was correcting and marking the tests and, within that role, they could write whatever they wished on the cards with the answers. Those three sets of answers were subsets of the 10 answers given in the first stage of the interview. Each was organized to include a grading of marks from zero to the answers' maximum value, according to the teachers' marking.

Teachers' evaluation criteria are concretized in tests: in each student's answer, through the marking the teacher gives it and through the notations and informations he or she writes at the side of the answer. When we placed the student in the role of the teacher, we assumed that the student, in performing that role, would reproduce teachers' criteria and that the degree of reproduction of the evaluation criteria would give a measure of the degree of acquisition of the realization rules in the evaluative context. Thus, we established that the student had realization rules when he or she gave a mark equal to the one attributed by the teacher and when he or she used the same notations as teacher's. We shall first analyze teachers' evaluation criteria; then we will follow it with an analysis of the reproduction of these criteria by students. The latter will be done with reference to the former.

Teachers' Evaluation Criteria. Teachers' evaluation criteria were inferred from the text they produced when correcting the tests, and also from the marking matrices they made when marking the tests. The analysis of this information revealed that both teachers of the sample did not write long text on students' answers but gave, without telling the students, a mark for each answer; and they also expressed their opinion through graphic signs.

Table 2
System for Categorizing Marking Principles Underlying Groupings

Recognition rules	Categories	Principles of marking	Examples and justifications for groupings
Does not possess recognition rules	1	Principle unclear • Does not make groups	2nd and 3rd questions: I am unable; I don't know.
		• Groups according to unclear principle	1st question: I made a group with . . . ordering the figures (A1, A2, A3, . . . A10) 2nd and 3rd questions: This says . . . and this says . . . (reads only the answers of each grouping).
	2	Similarity of answers • In terms of global scientific context	1st, 2nd, 3rd questions: They [questions] are similar; they mean the same.
		• In terms of decontextualised elements	Groups these which have the same/similar words. 2nd question: [In the 1st group] that which talks of roots, others don't tallk; [in the 2nd group] the question which talks of soil being less rich, others don't talk; [in the 3rd group] those which talk of horizons.
	3	Attempt to make correct answers	1st and 2nd questions: All make a complete answer
May not possess recognition rules	4	More or less correct answers	1st, 2nd, 3rd questions: In the 1st group those which are more complete/right; in the 2nd group those which are less complete/right. In the 1st group the best; in the 2nd the following; [. . .] and [finally] the worst.[5]
Possesses recognition rules	5	Correct/incorrect answers • Without intermediate degrees	1st, 2nd, 3rd questions: In the 1st group those which are well/correct/right; in the 2nd group those which are bad/incorrect/wrong.
		• With intermediate degrees	1st, 2nd, 3rd questions: In the 1st group those which are better; in the 2nd those more or less correct; in the 3rd those less correct; in the 4th those which are wrong.

For analytic reasons, we consider two components of these criteria: the criteria for marking and the system of graphic signs (Tables 3 and 4).

Whereas the marking criteria were similar for both teachers, there were differences in the systems of signs used by them. The sign system of the teacher of School X was more complex and less consistent than that used by the teacher of School Y. In fact, the former included a much greater variety of signs than the latter and also a multiplicity of relations between the sign and its meaning, which in the latter was only verified in the case of an incorrect answer. Further, the analysis of the texts produced by teachers showed that the teacher of School X used, in general, several signs for each answer, whereas the teacher of School Y used only one sign for each answer. An example of this is the following text produced by each one of the teachers for an answer to the second question of the interview.

School X: answer which is marked with two thirds of the total value:

√// Because it has topsoil, horizon A, horizon B, and bedrock. √

School Y: answer which is marked with two thirds of the total value:

This statement means that the plants take out of the soil their own food. inc

The text produced by the teacher of School X, which may seem to be more explicit in the evaluation criteria, is in fact more confusing in terms of that explicitness and more difficult for students to understand than that of the teacher of School Y.

Reproduction of Evaluation Criteria. As we pointed out before, the study of the acquisition of realization rules involved two parallel analyses, because we had to compare the text produced by students with that produced by their teacher. Further, each one of those analyses was initially developed in two stages: interpretation of students' answers in terms of the mark given and in terms of the graphic signs used. The data obtained were then combined.

In the first stage, we focused on the mark given by the students to each answer, a mark

Table 3
Criteria for Marking Used by Teachers

Criteria for marking	Teacher of School X	Teacher of School Y
1. Gives the value of each question	No	No
2. Gives the mark of each answer	No	No
3. Gives 0 points to inadequate answers	Yes	Yes
4. In the 1st question, distributes the total value by the various parts of it (2 points to each one of them)	Yes	Yes
5. Devalues the answer		
• if the student answers more than asked	No	Yes
• if the student does not use a correct language	Not always	Yes
• if the answer contains spelling mistakes	No	No

Table 4
Systems of Notations Used by Teachers

Teacher of School X		Teacher of School Y	
Notation	Meaning	Notation	Meaning
———	Underlines inadequate words	/; *m*	Crosses out the wrong word(s)
———	Crosses out words incorrectly written and sometimes corrects them	*x*; /	Crosses out the wrong answer or the space for it when the student does not answer
x; *m*	Crosses out the wrong answer or the space for it when the student does not answer	*C*	Signals the correct answer
√	Signals the correct answer	*Cx*	Considers the answer as correct but a common sense language is used
√/; √//; √///	Signals the globally correct answer with one, two or three strokes when there are incorrections in the use of language but not always explicate them	inc	Incomplete answer
		?	Unintelligible answer
?; ??; ???	Signals the answer to the question when it is inadequate, unintelligible, incomplete or when the student does not answer		
√?/√??	Incomplete answer		
O	Circles what is out of the context of the answer		

whose meaning was evaluated on the basis of the justification offered by students. The comparison between the mark given by the students and by their teacher for each set of answers led to the construction of a system of categories which is shown in Table 5. Because no student attained the maximum degree of realization (i.e., marking the five answers as the teacher did), this category was not included.

In the second stage, we focused on the reproduction of the graphic signs. We considered the student to have realization rules at this level when he or she used correctly one or more of the signs used by the teacher. By correct use, we mean the use of the teacher's sign with the meaning she gave to it, although in the context of the marking of the answer by the student. For example, let us assume that a student from School Y gives half of the value to an answer "because it was incomplete." We considered it to be correct if the student used the notation "inc.," independently of this being the judgment of the teacher. This notion of "correct use" led to the need for further articulation of the two stages, as the first contextualises the second.

Students of School X used only some signs (*X*, ?), whereas students of School Y used the whole system of their teacher's signs. In each set of answers, no student used more than three graphic signs in a correct way. Some students of both schools occasionally used signs different from their teacher's (e.g., the use of *C* instead of √ in School X and *C*// instead of inc. in School Y). These were considered to be an incorrect use of graphic signs. The analysis of the texts produced by students led to the system of categories shown in Table 6. Students who marked the answers using signs in both correct or incorrect ways were included in Categories 3, 4, and 5, contingent upon the number of correct signs offered by the student.

Table 5
System for Categorizing Marks Given by Students to Classmates' Answers

Realization rules	Students' behavior	Examples and justifications
Does not possess realization rules	1 Gives to all answers a mark different from teacher's:	
	• Always gives a higher mark than the value attributted to the question	• I think the question is undervalued; it should have a higher value.
	• Values an answer (or part of it) which is out of context	• It does not answer the question, but is well/good for another question.
	• When marking takes into account spelling mistakes	• I took out 1 point because of the mistakes
	• Distributes the value of the question in a way different from teacher's	• I took out 1 point because only one little bit was correct.
Possesses realization rules	2. Gives the same mark as teacher's to one answer	For correct answers: It means the same as that one (answer given), by different words.
	3. Gives the same mark as teacher's to two answers	For incorrect answers: It is wrong; it does not make sense.
	4. Gives the same mark as teacher's to three answers	For partially correct answers: It is incomplete; one cannot understand this part (reads to explicate). It is
	5. Gives the same mark as teacher's to four answers	well but it has not the right words; the answer is not finished, it does not tell . . . (and explicates).

Results and Interpretation

Acquisition of Recognition Rules: Relation to Social Class and School Social Context

A synthesis of the results obtained for the three questions, according to the methodology we described is shown in Table 7. The acquisition of the recognition rules was significantly higher for middle-class students and slightly higher for working-class students of School Y compared to students of School X. This held for the three questions. Figure 4 offers a clearer idea of the

Table 6
System for Categorizing Notations Used by Students in Correcting Classmates' Answers

Specific coding orientation	Students' behavior
Does not possess realization rules	1. Does not use any notations.
	2. Uses notations *always* in an incorrect way.
Possesses realization rules	3. Uses *one* notation correctly.
	4. Uses *two* notations correctly.
	5. Uses *three* notations correctly.

Table 7
Acquisition of Recognition Rules (Percentage) by Students of the Two Schools According to Social Class and for Each One of the Three Questions

	School			Social Class			Question		
	School X			School Y					
	WC			WC			MC		
Recognition rules	Q-1	Q-2	Q-3	Q-1	Q-2	Q-3	Q-1	Q-2	Q-3
Possesses	0	8	8	17	8	17	56	56	56
Does not possess	58	42	50	67	67	58	44	44	33
May possess	42	50	42	17	25	25	0	0	11
				[a]					

[a] Total is higher than 100 due to rounding.

results by comparing, for each question, the percentage of students of each social group who have acquired recognition rules.

Table 7 shows that the number of students who *may* possess recognition rules was relatively high. This led to a more delicate analysis by giving to the acquisition of the recognition rules (per the categories shown in Table 2) a score on a numeric scale (Table 8). The use of the scale allowed the possibility of attributing a score to each student which gave a degree of acquisition of the principles of marking.

Total values for the three items could vary between 0 and 6. We translated this into a 4-point scale, which, according to the data obtained, gave four degrees of acquisition of recognition rules:

0–1: *Very low:* Students may possess recognition rules for one question but the answer was not explicated, or they do not possess recognition rules for any of the three questions.

2: *Low:* Students may possess recognition rules for two questions but the answers were not explicated.

3: *Medium:* Students may possess recognition rules for three questions but the answers were not explicated.

5–6: *High:* Students explicitly possess recognition rules for at least two questions.

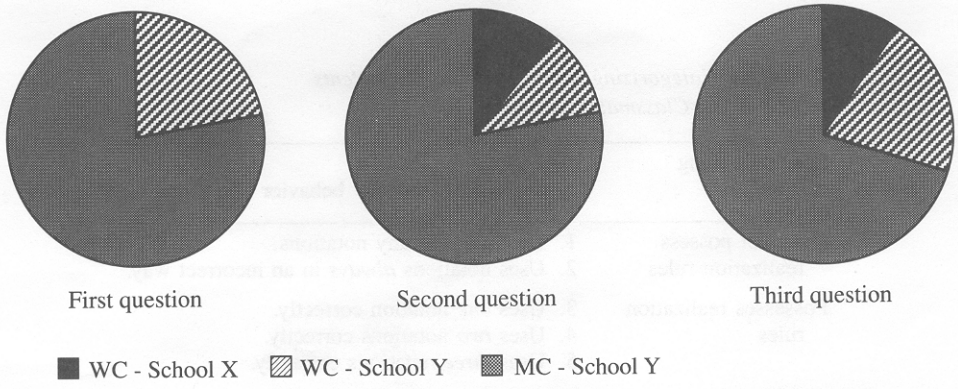


Figure 4. Acquisition of recognition rules for each one of the three questions.

Table 8
Scale for the Principle of Classification Selected

Recognition	Scores	Principles of Classification
Did not recognize	0	Categories 1, 2, and 3
May have recognized but did not explicate that recognition	1	Category 4
Explicated the recognition	2	Category 5

Table 9 shows the relation between the school and social class of students and the degree of acquisition of recognition rules. The table shows that middle-class students acquired the recognition rules to a high degree; they had either a high or very low degree and were never intermediate. Working-class students are, in general, and in decreasing order, from very low to low, and medium; only two students acquired the recognition rules to a high degree. There was no significant difference in the degree of acquisition of the recognition rules between the working-class students of the two schools.

Acquisition of Realization Rules: Relation to Social Class and School Social Context

Table 10 shows that students had, in general, more difficulties in the acquisition of realization rules relative to the question of application of knowledge, and this was particularly true for the working-class students of School X. Middle-class students acquired the realization rules to a higher degree than did working-class students for any of the questions. Working-class students of School Y acquired the realization rules to a higher degree than did students of School X; this difference was especially significant for the question of greater complexity (application of knowledge). Figure 5 offers a clearer image of the results, by comparing for each question the percentage of students of each social group who had realization rules.

To evaluate the degree of acquisition of the realization rules, we proceeded with a more delicate analysis in establishing scores to correspond with the categories previously established (Tables 5 and 6). We noticed that some students placed notations only on the answers to the first question. We thought that this situation could be attributed not only to the level of difficulty of the questions, but also to their not understanding of the text of the question. To verify whether the interpretation of the answers was a factor interfering in the results, we analyzed the marks given by teachers in the three questions. This showed that several students obtained quite good marks in the first question and failed to do so in the second and third questions. If we also take into account that the test was not corrected in class before the interviews, we have to admit that difficulties of interpretation of the text of the answers may have affected the results. We then decided to give more credibility, in what refers to the acquisition of the realization rules, to the results obtained for the first set of answers, giving a higher score to these data. Thus, for the first question, we attributed two points to each answer marked correctly, and we did the same for each graphic sign used correctly. For the second and third questions, we attributed one point to each of those elements. The values used for the codification of the text produced by students are shown in Table 11.

It should be noticed that for the application of the system of graphic signs, we took into account the correct use of signs, and not their frequency. In fact, what we intended to see was whether the student was able to apply them. On the other hand, the results showed that for each set of answers when the students used a given sign they did so systematically.

Table 9
Acquisition of Recognition Rules by Students of Each School According to Social Class

School	FAQ	Students	Score				Degree of acquisition
			Q-1	Q-2	Q-3	Total	
X	WC	25	0	0	0	0	Very low
		3	1	1	1	3	Medium
		2	1	1	1	3	Medium
		12	0	0	0	0	Very low
		9	0	0	0	0	Very low
		18	1	1	1	3	Medium
		13	1	1	0	2	Low
		36	0	0	0	0	Very low
		38	0	0	0	0	Very low
		29	0	1	1	2	Low
		42	0	1	1	2	Low
		5	1	2	2	5	High
Y	WC	73	0	0	0	0	Very low
		56	1	1	1	3	Medium
		54	0	0	2	2	Low
		57	2	2	2	6	High
		63	0	1	1	2	Low
		78	2	0	0	2	Low
		90	0	0	0	0	Very low
		72	0	0	0	0	Very low
		87	0	0	0	0	Very low
		82	0	0	0	0	Very low
		45	1	1	1	3	Medium
		67	0	0	0	0	Very low
	MC	50	2	2	2	6	High
		83	2	2	2	6	High
		68	0	0	1	1	Very low
		53	0	0	0	0	Very low
		77	2	2	2	6	High
		81	2	2	2	6	High
		58	2	2	2	6	High
		44	0	0	0	0	Very low
		69	0	0	0	0	Very low

Table 10
Acquisition of Realization Rules (Percentage) by Students of the Two Schools According to Social Class and for Each One of the Three Questions

	School			Social Class			Question		
	School X			School Y					
	WC			WC			MC		
Realization rules	Q-1	Q-2	Q-3	Q-1	Q-2	Q-3	Q-1	Q-2	Q-3
Possesses	58	58	17	83	75	75	100	100	89
Does not possess	42	42	83	17	25	25	0	0	11

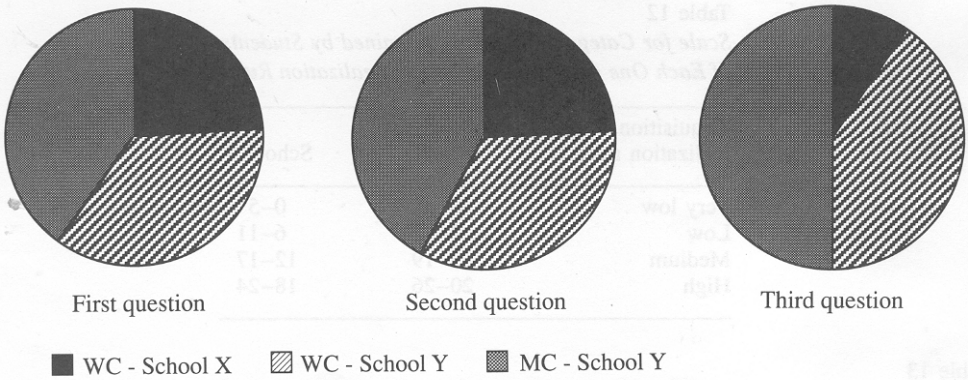


Figure 5. Acquisition of realization rules for each one of the three questions.

The score attributed to each student was categorized according to the scale in Table 12. This scale was constructed on the basis of the text produced by teachers of each school when they corrected and marked the answers which we gave to students in the interview. Codification of both teachers' texts according to the same criterion, and assuming that the students had the same degree of difficulty in interpreting the answers given to the three types of questions, gave 26 points to the teacher of School X and 24 points to the teacher of School Y. As an example, let us consider the following answer (A_1) to the third question of the test of School X, as it appears in the corrected test: "Without the soil producers we did not have to walk on the living things which had died or else we had to bury them and with the microorganisms there is no need for that.$\sqrt[?]{}$." The maximum value which could be attributed to the correction of that answer would be 3 points: 1 for the mark given (which was the same as the teacher's) and 2 for the use of two graphic signs (__ and $\sqrt[?]{}$). We followed this procedure for each of the five answers and obtained a total of 26 points for the teacher of School X and 24 points for the teacher of School Y. We then established that 26 and 24 would be the maximum values that students of each of the two schools could achieve.

Table 13 shows the score for each student and the respective degree of acquisition. The data show that students who possessed a high degree in the acquisition of realization rules were those of School Y and, moreover, predominantly of the middle class. Further, it shows that students of the working class of School Y were widely scattered on the scale, whereas students of School X did not achieve a medium degree of acquisition of the realization rules.

Table 11
Codification of Text Produced by Students for Realization Rules

	Score					
	Marking of Answers			Use of Notations System		
Category	Q-1	Q-2	Q-3	Q-1	Q-2	Q-3
1	0	0	0	0	0	0
2	2	1	1	0	0	0
3	4	2	2	2	1	1
4	6	3	3	4	2	2
5	8	4	4	6	3	3

Table 12
Scale for Categorizing Scores Obtained by Students of Each One of the Two Schools in Realization Rules

Acquisition of realization rules	School X	School Y
Very low	0–6	0–5
Low	7–12	6–11
Medium	13–19	12–17
High	20–26	18–24

Table 13
Acquisition of Realization Rules by Students of Each School According to Social Class

			Score									
			Marking of Answers				Use of Notations System					Degree of
School	FAQ	Students	Q-1	Q-2	Q-3	Subtotal	Q-1	Q-2	Q-3	Subtotal	Total	acquisition
X	WC	25	2	1	0	3	0	0	0	0	3	Very low
		3	8	1	1	10	2	0	0	2	12	Low
		2	0	0	0	0	0	0	0	0	0	Very low
		12	8	1	1	10	0	0	0	0	10	Low
		9	2	1	0	3	0	0	0	0	3	Very low
		18	6	1	0	7	0	0	0	0	7	Low
		13	0	0	0	0	0	0	0	0	0	Very low
		36	0	0	0	0	0	0	0	0	0	Very low
		38	0	0	0	0	0	0	0	0	0	Very low
		29	0	0	0	0	0	0	0	0	0	Very low
		42	0	1	0	1	2	1	0	3	4	Very low
		5	0	1	0	1	2	0	0	2	3	Very low
Y	WC	73	0	1	2	3	0	0	0	0	3	Very low
		56	2	1	2	5	4	2	0	6	11	Low
		54	2	0	4	6	2	0	0	2	8	Low
		57	2	1	1	4	4	1	0	5	9	Low
		63	2	1	0	3	4	2	1	7	10	Low
		78	6	0	0	6	0	0	0	0	6	Low
		90	2	1	2	5	0	0	0	0	5	Very low
		72	4	2	4	10	4	2	2	8	18	High
		87	4	2	0	6	4	2	1	7	13	Medium
		82	2	0	0	2	0	0	0	0	2	Very low
		45	2	1	0	3	4	2	0	6	9	Low
		67	0	1	2	3	0	0	0	0	3	Very low
	MC	50	8	4	3	15	2	2	2	6	21	High
		83	6	3	3	12	4	1	2	7	19	High
		68	6	1	2	9	4	2	1	7	16	Medium
		53	4	3	3	10	4	2	2	8	18	High
		77	6	3	4	13	6	2	3	11	24	High
		81	6	1	4	11	4	2	2	8	19	High
		58	4	2	3	9	4	0	0	4	13	Medium
		44	0	0	0	0	2	1	0	3	3	Very low
		69	0	0	0	0	2	1	1	4	4	Very low

Specific Coding Orientation: Relation to Students' Scientific Knowledge

We determined the degree of acquisition of recognition and realization rules by associating numeric scales to systems of categories. We then determined the specific coding orientation of each student through a composite index[6] made from recognition and realization. The values obtained for specific coding orientation were then analyzed in terms of their relation to students' scientific achievement either in their global score or separated by simple and complex cognitive competencies.

The analysis of the correlations showed that there was a statistically significant relation between coding orientation and global achievement ($r = .54$) and between coding orientation and achievement in complex competencies ($r = .58$). The relation between coding orientation and achievement in simple competences had lower significance ($r = .24$). Acquisition of the specific code in the assessment context is therefore related to the level of scientific knowledge attained by students, namely, in complex competences.

Conclusion

The analysis of the evaluation criteria of the teachers of the two schools led us to conclude that there were no major differences in the marking criteria of the two teachers. On the other hand, the system of notations of the teacher of School X was more complex and less consistent than that of the teacher of School Y. Neither teacher was very explicit in the evaluation criteria (e.g., the percentage of the total value of the question they attributed to the answers was not indicated, and the meaning of "incomplete" was not explicated. The analysis of the system of notations, however, indicated that students of the teacher of School Y had an easier task in constructing an understanding of the system. This means that although both teachers transmitted little of their evaluation criteria, the form of transmission by the teacher of School Y was more helpful. In other words, the teacher of School Y may not have explicated *more*, but explicated *better*.

The text produced by both teachers and students in the correction of answers referred to the ID and it was in this context that the previous analysis was carried out. However, as we referred in the theoretic framework of the study, the RD always dominates the ID and, as a consequence, both dimensions of pedagogic discourse are transmitted through the instructional practice, although the RD is not always explicated. We can characterize teachers' pedagogic practice in the transmission of the evaluation criteria as practices of weak framing in the ID and strong framing in the RD. In fact, if we consider the model and the scale shown in Figures 1 and 2, respectively, and the codification of the evaluation criteria shown in Tables 3 and 4, we can see that both teachers were placed in the area of weak framing at the level of instructional context and in the area of strong framing at the level of regulative context. However, the fact that the teacher of School Y used a system of notations more accessible to students' understanding than the system used by the teacher of School X led us to admit a difference in the framing degrees of the pedagogic practices of the two teachers. This led to the attribution of a less weak framing in the ID and a less strong framing in the RD to the practice of the teacher of School Y compared to that of the teacher of School X.

When we studied the recognition rules, we saw, in a first analysis, that middle-class students had a higher attainment of those rules compared to working-class students, and that within the working class, there was a slight difference between the students of the two schools in favor of School Y. When we carried out a more delicate analysis and determined the degree of acquisition of recognition rules, we saw that the slight difference between the working-class

students of the two schools blurred, but the difference between the two social classes tended to be more marked: The high degree of recognition was attained by most middle-class students and only by two working-class students, and the intermediate degrees (low and middle) were only attained by working-class students. The lower degree included some middle-class students and fundamentally working-class students.

When we studied the realization rules, we saw that, in a first analysis, middle-class students showed a higher acquisition of the realization rules for the three types of questions compared to working-class students. Although students of both social classes had shown growing difficulties when the complexity of the questions increased, differential acquisition of realization rules between students of the two social classes were accentuated at the same time, most especially when comparison is made with students of School X. When we carried out a more delicate analysis and determined the degree of acquisition of realization rules, we saw that the high degree was essentially attained by middle-class students and that working-class students of School X were always below the medium degree. Working-class students of School Y were mainly placed in the two lower levels of the scale, although their rank ranged across all realization degrees.

In summary, the results showed that middle class students acquired the recognition and realization rules for the assessing context in higher degree than working class students and that, within the working class, were the students of the school located in the town who had, in general, acquired those rules in higher degree. There was also a differential acquisition of the realization rules according to the type of question, students showing a lower degree of acquisition in the question of concept application. This held particularly for the working class of the rural school.

The study showed, therefore, that there is a relation between students' acquisition of recognition and realization rules and social class, on the one hand, and school's social context on the other. A higher conceptual demand makes it more difficult to understand the teacher's evaluation criteria (the case of the third question), although a teacher with a general high conceptual demand but simultaneously clearer criteria (teacher in the town) can enhance understanding. The influence of the explicitness of the criteria could, perhaps, have been clearer had the two teachers been more different in their conceptual demands. We should be cautious about the influence of the explicitness of the evaluation criteria on the acquisition of the specific coding orientation (recognition and realization rules), because the two pedagogic practices were not sufficiently distinct with respect to that explicitness. However, the results suggest a clear trend in the direction of a correspondence between higher explicitness of evaluation criteria and higher acquisition of realization rules by working-class students.

The study also shows a relation between the specific coding orientation in the assessing context (recognition and realization rules) and students' scientific achievement, especially in complex cognitive competencies; poorer achievers had not acquired the recognition and realization rules (i.e., the more effective the reproduction of the teacher's evaluation criteria was, the higher the level was of students' scientific knowledge, namely in complex cognitive competencies).

It was clear that many students, especially those disadvantaged in terms of social class and social context, do not understand teachers' evaluation criteria. This will make their access to the text legitimized by the school difficult. The importance of explicating the evaluation criteria already shown in other studies (Morais et al., 1992, 1993; Morais & Antunes, 1994; Morais & Nunes, 1994; Morais, Neves, Antunes, Fontinhas, Medeiros and Peneda, 1995; Ferreira & Morais, in press), in other subcontexts of the science classroom (e.g., problem solving), is again highlighted in this study. Teachers' awareness of this fact seems crucial and may contribute to the implementation of pedagogic practices leading to scientific literacy.

The authors are grateful to their colleague Isabel Neves for many valuable suggestions. They also acknowledge the Gulbenkian Foundation for financing the research.

Notes

[1] Social class is here taken as a nominal concept.

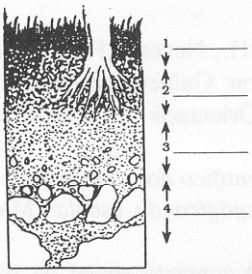
[2] The scale for fathers' academic qualifications represents a compromise between levels of schooling and number of students of the sample in each category. 1: Cannot read or write; attended/completed primary schooling; attended preparatory school. 2: Completed preparatory school; attended middle school. 3: Completed middle school; completed a medium-level course after preparatory school; attended high school. 4: Completed high school; completed a medium-level course after middle or high school; attended university; obtained a university degree.

[3] The following are those questions given to students which are needed to understand the text:

School X

Acquisition of factual knowledge

Q-1 The figure represents the profile of a soil. Observe it carefully.
Make the legend of the figure.



Concept understanding

Q-2 The figure [the same of the above question] represents the profile of a soil. Observe it careffuly.
We can say that the soil represented is a mature soil. Why?

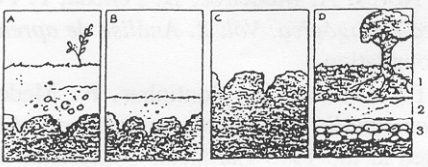
Concept application

Q-3 "Without the microrganisms of the soil life on earth would be impossible".
Explain the meaning of this sentence.

School Y

Acquisition of factual knowledge

Q-1 Make the legend of scheme D.



1 _____
2 _____
3 _____

Concept understanding

Q-2 [The same figure of the above question] "The plants in the figure are producers". Justify this statement.

[4] The final structure of the interview was the result of changes made on the basis of the results of the two pilot studies.

[5] The student never says there are incorrect answers.

[6] The composite index was determined by

$$SCO = \frac{Rec + Real}{N} \times 100$$

where *Rec* = degree of acquisition of recognition rules; *Real* = degree of acquisition of realization rules; and *N* = Sum of the maximum values for recognition and realization rules. For students of School X, *N* is 32 (6 for recognition rules and 26 for realization rules). For students of School Y, *N* is 30 (6 for recognition rules and 24 for realization rules).

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