DOCUMENT RESUME

ED 407 262 SE 060 199

AUTHOR	Jimenez-Aleixandre, Maria Pilar; Diaz de Bustamante, Joaquin
TITLE	Analysing Classroom Discourse: Practical Work in the Biology Laboratory.
PUB DATE	24 Mar 97
NOTE	33p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL, March 24, 1997).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Biology; *Classroom Communication; Foreign Countries; Grade 11; Group Activities; High Schools; *Inquiry; Laboratories; Learning Strategies; *Microscopes; Science Education; Student Attitudes; Teaching Methods
IDENTIFIERS	Spain

ABSTRACT

This study is part of a larger study on the problems that high school students' have in the interpretation and production of drawings and graphic representations in practical work in the biology laboratory, specifically with the use of the microscope. This part of the study focuses on classroom discourse among students and teacher as they use the microscope and other classroom materials (i.e., handouts, texts, and notebooks). The questions explored included the amount of involvement in inquiry that the tasks required and its relation to the discourse, the categories (qualitative and quantitative) of interactions, and what could be considered practical work on biology versus what could be coded as display. Methodology involved videotaping and observing 11th grade students working in groups. The tapes were transcribed and coded for both verbal and nonverbal interactions. Discussion includes identifying features of discourse that may be better described as archetypal tasks framed in school culture rather than as inquiry. It is concluded that a different approach to lab work is needed in which it should be made explicit not just how to do the tasks but also why and for what purpose the tasks should be done. Contains 18 references, 3 tables, and 5 figures of data. (Author/PVD)

Analysing Classroom Discourse: Practical work in the Biology laboratory

Jiménez-Aleixandre, María Pilar & Díaz de Bustamante, Joaquín

Dpt. Didactica das Ciencias Experimentais
University of Santiago de Compostela (Spain)
Avda. Xoán XXIII s.n. 15704Santiago de Compostela
email ddmaleix@usc.es

Paper presented at the American Educational Research Association (AERA) annual meeting, Chicago, IL, March 24th - 28th 1997

This paper is based on work supported by the Spanish Dirección General de Investigación Científica y Técnica (DGICYT), grant PB 94-0629.

Abstract

This paper reports a study, part of a larger one about the problems related to High School students' interpretation and production of drawings and graphic representations in the context of Biology practical work in the laboratory, involving the use of microscope. This part of the study focuses in the classroom discourse, in the interactions involving students, teacher, microscope and other (handouts, texts, notebooks). The questions explored included a) the involvement in inquiry required by the tasks and its relation to the discourse b) the categories (qualitative and quantitative) of interactions and c) what could be considered as practical work on Biology, and what could be coded as display. The methodology involved videotaping and observing 11th Grade students working in groups. The tapes were transcribed and coded for both verbal and non verbal interactions, and different ways of representation, included graphical, were designed. Discussion includes features of discourse that may it better described as archetypal tasks framed in school culture, than as inquiry, and goals.

1 Classroom discourse in the Biology laboratory

The role of practical work in science learning has been much debated, discussing issues such as motivation, skills development and learning about scientific methods (Hodson 1994). Practical work is expected to meet different learning goals but, as Hodson (1986) suggests, there is a need to design specific learning experiences for specific learning goals, and if it is true that children expect to carry out practical work in order to find out what scientists do, the way in which much laboratory work is designed and conducted in schools leads to a distorted view of science, related for instance to the reliability of observation.

This paper focuses on the issue of learning about how scientists work, that we would reformulate as engaging students in scientific inquiry (Duschl & Gitomer 1996). Our hypothesis is that such objective is usually not sought in laboratory activities in Spain, and particularly that the tasks set in microscope related work have a low level of inquiry. As «inquiry» has been assigned diverse meanings through the educational literature, it is necessary to discuss what we mean by inquiry in this paper. Connelly, Finegold, Clipsham & Wahlstrom (1977) see inquiry with three meanings, all contributing to the definition: 1) as the logical processes used in the development and verification of knowledge; that is related to invention, discovery, guiding conceptions, theoretical speculations etc.; 2) as a mode of learning, related to divergent thinking and problem-solving, and that they formulate as how students investigate scientific patterns of thought; 3) as an instructional methodology, that they relate to challenging students to defend their views, arguing from data or theoretical knowledge. Sometimes inquiry has been identified with discovery learning, with hands-on activities disconnected from theories or concept issues, but it is worth noting the central role that reasoning plays in the inquiry perspective: as early as 1972 Connelly defined «inquiry in biology as the development and use of logical forms and explanatory accounts» (Connelly 1972, page 386). In the National Standards (National Research Council 1996) inquiry is said to refer both to the diverse ways in which scientists study the natural world and to the activities of students in which they develop knowledge and understanding of scientific ideas as well as understanding of how scientists study the natural world. We see this view in the National Standards coherent with the perspective suggested by Connelly et al (1977), as it mentions both the development of knowledge and the mode of learning, which in our opinion is connected to certain instructional methodologies. When defining inquiry the National Standards say that it involves making observations; posing questions; examining different sources of information; planning investigations; reviewing knowledge in light of experimental evidence; using tools to gather, analyze and interpret data; proposing answers and explanations, and communicating results; and that inquiry requires the use of critical and logical thinking. All this related to learning «the scientific way of knowing the natural world» (National Science Education Standards page 23).

In summary, what we mean by inquiry in this paper is a perspective of learning that includes learning the scientific way of knowing the natural world, in other words, understanding about scientific knowledge. As Duschl & Gitomer (1996) point, the attainment of teaching science as inquiry has proven elusive until now, and they relate this failure to the emphasis on concept and process skills goals rather than on epistemic and representation goals. For Duschl and Gitomer scientific inquiry involves moving from evidence to explanation, and requires epistemic judgements, that is judgement about beliefs and explanations about nature; about methods of data collection or analysis. In this paper we try to analyse practical work, particularly microscope observation, in High School from the perspective of its relation to inquiry.

Science learning is now viewed not only as a cognitive activity but also as a social one; Brown, Collins & Duguid (1989) argue that academic disciplines should be viewed as cultures, and that one of the reasons for the inability to use knowledge may be that students are asked to use the tools of a discipline without being able to adopt its culture. These authors distinguish authentic activities, framed in the culture of authentic practitioners (in our case scientists), and archetypal school activities, framed in the school culture, and that contrary to the aim of schooling, do not produce learning that could be used elsewhere.

Our understanding of the scientific enterprise has been extended by the sociological approach through study of current scientific practice (Latour & Woolgar 1986), and recently this sociological perspective has been applied to the study of science curriculum and classrooms, and school labs: Cunningham (1996) analyses curriculum reform documents from the perspective of their treatment of sociological issues, and proposes a new component of teacher knowledge, sociological understanding of science (SUS), required for implementing current initiatives calling for instruction that promotes understanding of scientific practice. Kelly & Crawford (1996) study High School student laboratory groups from the perspective of the sociology of science, exploring what counts as science in this classroom; they identified several views of science related to stereotypes such as the existence of a standard "scientific method", or the belief that science is unproblematically discovered, concluding that the mere exposure to the complexities inherent in doing scientific investigations is not sufficient to challenge these stereotypes, and that the ambiguities of using data to create evidence and arguments need to be explicitly discussed and validated. This study by Kelly & Crawford exemplifies a new way to explore students' views of science through direct study of classroom discourse, rather than through analysis of reconceptualized answers to particular instruments.

We are focusing here in the classroom discourse, «discourse» here having the meaning that Lemke (1990) assigns to it, not just as language, but as the language-in-use in a community, in these Biology classroom communities, particularly in the microscope sessions in the Biology laboratory. Our focus is "what counts as practical work in School Biology?", coding verbal and non-verbal interactions among actors, and trying to identify practices which relate to practical work in Biology, to authentic tasks performed by biologists, and other practices which may be better described as part of the school culture, as the procedural display (Bloome, Puro & Theodorou 1989) which count as acting as "Biology students", but that may not necessarily be related to actual learning.

In the second section we present the objectives of the study, then the methods of analysis and data sources, and in the fourth section the findings. Finally we discuss educational implications and future research questions.

1 Objectives of the study

The objectives of the larger study from which this work make part relate to the interpretation and production of drawings and images in the context of High School Biology laboratory work, in particular to explore the difficulties of High School students when working with the microscope. Although the teaching and learning of Biology relies strongly upon the use and interpretation of pictures, drawings and micrographs, only a few papers in the literature (for instance Wandersee 1996) deal with it, and none, to our knowledge, focuses on classroom or laboratory observation. The problems encountered by students when interpreting microscope observations and drawing the samples, as revealed by the drawings, are discussed in other papers, for instance Díaz & Jiménez (1997). What we undertake in this paper is a case study trying to document the development of four laboratory sessions, and analyzing this development with relation to inquiry (the scientists culture), and to the school culture. The particular objectives of the work reported here are:

1) To identify the involvement in inquiry both as required by the tasks set by teacher and as performed by students in laboratory sessions involving the use of the microscope.

2) To identify and code the interactions occurring during the sessions

3) To analyse the discourse, verbal and non-verbal interactions, and to identify the performances and interactions relating to the assumed goals, and the ones which could be coded as display.

3 Methods and data sources

– Participants and classroom context; data collection

In the first part of the study a dozen of High School Biology laboratory sessions, and two dozens of University Biology laboratory sessions, all of them involving the use of microscope, and always part of the normal course or programme, have been videotaped, and observed by the second author. In this paper data from four of these High school sessions are discussed. The sessions were conducted by the teachers as part of the regular coursework, and interference by the researcher –who had been there in other sessions– was kept to a minimum, that is his presence and the camera. The teachers and students were asked if they wanted to participate in the study, although the particular focus was not made explicit. The four sessions correspond to the same topic, lily epidermis, in four different classes from the same High School, a typical public (state) High School in the small city (100.000 inhabitants) of Santiago de Compostela, recruiting students both from downtown Santiago and from the city suburban area.

The pupils were 11th Grade students (aged 16-17 years) enrolled in Biology-Geology as part of the Science track they have choosen. Although in Spanish schools there are around 35 students in each whole class, for laboratory sessions they are divided in groups of 20 students. The students work in groups or teams of three or four sharing a microscope (in one of the cases studied they were five, what is quite unusual). The study focuses on the performance of four of these teams, one in each session, composed by three, four or five students. There is little immigration in this area, and all the students share the same ethnical background. The pseudonyms used maintain the students' gender; in this study we have used names beginning with the same letter in each team. It is worth noting that the great majority of the teams, like the four studied here, were gender-homogeneous, only girls, like teams in A1 and A2, or only boys, like teams in A3 and B5. This question has been much discussed in the gender and science education literature in Spain, but it is not explored in our study, and it has relevance only to the question of gender relations inside the teams that, because of the homogeneity, cannot be explored here.

The sessions were taught by two teachers; teacher A taught three sessions, A1, A2 and A3 and teacher B one session, B5. Both teachers are woman, with more than 15 years of teaching practice, and both are active in professional associations and usually attend teachers' conferences.

– The task

The session topic was "microscopic observation of cells from lily epidermis". Students received detailed written instructions about how to take the sample and do the preparation. They were directed to look for chloroplasts, and asked to produce a drawing of the two types of cells (epidermic and stomata), labelling all the structures and elements that they were able to find. They were also asked to estimate the actual size of the cells. We copy below a translation of the last paragraph of the handout, where they were told what they were expected to produce. Although they worked in teams, they were expected to produce individual drawings and reports.

> «Make a drawing of the sample, labelling the two types of cells found, and in each type the structures and elements that you are able to distinguish (if you cannot see the nucleus of the epidermic cells, add, without removing the cover glass, a drop of methylen blue). You have to estimate the actual size of the cells, both epidermic, and of stomata.»

In the four sessions the teachers supplemented these instructions with verbal comments and orientations, addressed to the whole class, discussing some of the difficulties which could arise. Then they were available to the questions from the teams, and in some occasions, prompted by difficulties encountered by a team or student, addressed again the whole class.

The camera was set, always in the same bench, before the students entered the laboratory. When a group took seat in this bench, they were asked to volunteer to be recorded, if they were not willing, they were asked to change seats with another group. The microscopes were checked by the observer-researcher before the beginning of the session, and at the end of the task, to be able to see the sample that the students were observing.

The data sources are: the video recordings, the field notes of the observer-researcher, the handouts and the drawings and reports produced by the students.

– **Methods of analysis**

Two complementary analysis were performed, the first related to the involvement in inquiry, as required in the task, and performed by the students, and the second related to the interactions. Then performances and interactions were coded as practical work or as display.

a) For the analysis of the involvement in inquiry in the tasks and performances, we identified six different categories of activities involved in inquiry and requirements for it, using as sources the discussion about inquiry in the National Standards (NCR 1996) and the Laboratory Assessment Inventory (Tamir & García 1992), attempting to elaborate a tool which enables a qualitative analysis, more than a detailed yes/no checklist. The categories are discussed in the next section, and shown in table 1.

The analysis of activities performed followed these steps:

- Establish expected performances both in the light of activities involved in inquiry, as shown in table 1, and in a prototypical sequence of microscope observation: follow instructions, manipulate, focus...

- View the tape and with the help of fieldnotes time separately each student, recording activities and time.

- Analyse teacher's instruction and students productions (drawings, notebooks)

- Reconstruct analysis grid including all activities

- Code all activities with the allocated time.

b) Analysis of interactions

- View the tape and with the help of fieldnotes, record types of interactions

- Construct a category list according to observed interactions. The category list with instances of transcriptions coded in the different categories is discussed in the next section.

- View the tape again and code the interactions according to type, number and time of duration.

A summary of the interactions is represented in flow charts, figures 2 to 5.

Combining both analysis, identify activities and interactions related to authentic practical work in Biology, and activities and interactions which are related to school culture, to acting as students.

4 Results of the analysis

- Involvement in inquiry

There are different inventories and checklists designed to asses the level of inquiry in practical work, for instance the L.A.I., Laboratory Assessment Inventory (Tamir & García 1992), but for our purposes they are too focused in exhaustively listing different types of activities, and assigning levels related to frequence of appearance. Our view of the inquiry perspective is less one of an exhaustive checklist, and more one of broad categories of activities involved in it. Using as a main sources the discussion about inquiry in Connelly et al (1977), Duschl & Gitomer (1996) and in the National Standards (NCR 1996), we grouped the activities in six categories: problems; relating problems to theory; investigations (plan and data collection); investigations (data analysis); relating data to theory and communicating the results. The categories and the main instances of activities grouped under them are depicted in table 1.

----

table 1 about here

In our opinion, to explore if students are involved in inquiry when performing practical work is not so much a matter of answering yes/no to each of the activities listed in table 1, because for some of them the answer could be yes/ no, whereas for other it is a question of degree. An analysis of the tasks which students were asked to perform and of their actual performances, compared to the activities in table 1, can give an indication of the presence or lack of each broad category.

The analysis of the task shows that students were asked only follow instructions, observe, measure, use apparatus, record results, perform numerical calculations and draw. There are no tasks corresponding for instance to the categories 1 problems, 2 relating problems to theory or 5 relating data to theory. The tasks correspond to:

Category 3 Investigations, plan and data collection: only to «using tools to gather data», and not to designing or planning, proposing hypothesis or deciding about procedures.

Category 4 Investigations, data analysis: to «using tools to analyse and interpret data», and to proposing answers.

Category 6 Communicating the results: to «using different notational systems».

There are no activities related to determining limitations or background knowledge; proposing theoretical explanations, or formulating new questions.

A different dimension that should be analyzed is whether task itself is a problem or not. An authentic problem, as defined by Duschl & Gitomer (1996), has two components to the authenticity: first, about the context, which has or could have a relevance to the students' lives, connected to everyday issues; in respect to this the task under consideration lacks this relevance. Second, about the examination of evidence that scientists themselves would use, which could be related to the activities listed under category 5, relating data to theory, in table 1; in respect to this the task does not demand this actions. In summary, It can be said that the task proposed to the students is not an authentic problem, and could better be described as an exercise; besides it is closed not open-ended, and the procedures are given.

The analysis of the activities actually performed by students show that they did not even perform all the activities asked to them: not all were fulfilled, or they were fulfilled only by some students in the team. The videotapes were analysed coding the diferent activities performed by each student, and the time spent on them. A summary of the activities of each team was produced, and as an instance the one corresponding to team A2 is reproduced in table 2. For each student it is recorded in the first column the total time spent on each activity, and in the second column the number of times that the activity or task was performed.

----

table 2 about here

As seen in table 1 there are big differences among students in each team; for instance in team A2 Bea is performing most or all of the activities related to getting the sample, mounting the slide, focusing etc.

The students had to produce drawings and estimate the cell sizes in a worksheet. The worksheets were collected in the classroom some days later, and we have analyzed not only those from the students in the four teams, but from all the whole class, although some students never delivered it. For instance, and with respect to the activities listed in the handout, the summary of how they were fulfilled in the teams, combining the data from the videotape and from the worksheets is represented in table 3.

---

table 3 about here

As seen in table 3 many of the activities were performed only by one of the students. With respect to actual observation through the microscope, which was supposed to be one of the main goals of the session, they devoted very little time to it, with differences among them, from 7 minutes 48 seconds the student who spent more time, to 25 seconds the one who spent the less. It has to be noted that the students in team A3, who spent more time observing, had a sample and slide of very poor quality which made nearly impossible to distinguish the two cell types or draw them; when looking through the microscope they were complaining about the difficulties or impossibility of observation, and they ended observing other teams' slides in order to do the drawings. So perhaps the longest time spent on observation has to be accounted to these difficulties. Also it is worth noting that the mean time for each episode of observation was very short as seen in table 2.

In the handout they were asked to draw two types of cells, labelling the elements, and it was mentioned than one of them was epidermic and the other stomata. From the drawings it can be said that only four of the students in team B5 were able to do this (the fifth student draws the cells but without any name), and perhaps this better results could be related to the quality of the sample and slide, which enabled observation, and also to the fact that two student in B5, Daniel and Denis were able to interpret what they observed, and to inform other students, like Del, about what to do. Most students produce drawings without even an indication of the nucleus or the cell wall, and four of them apparently did not see the stomata, or at least they do not draw them. A detailed analysis of the drawings of the whole sample studied can be found in Díaz & Jiménez (1997).

They were asked also to estimate the cells size, and the teacher explained verbally that to do it, they should take into account the magnifying. Apparently some of the students interpreted this task simply as record the magnifying alongside the drawings. In these four teams, only the three students in A1 estimated the size. From the videotape it can be seen that is Adela who first estimates it, and then she informs the other two students about how to do it.

A timeline was constructed for each team, showing the overall distribution of time for each subtask. The four timelines are depicted in figure 1. The sessions were supposed to last 50 minutes, but at the beginning the students spent some time coming from the previous session, in a different room and floor and unpacking, and at the end they spent some time arranging the microscopes into their cases and cleaning up. The timelines begin when all students are seated, and the teacher starts to give directions. As seen in figure 1 the team B5 in a group taught by a different teacher from teams A1, A2 and A3, spent about half session observing a different sample, so the time spent working on lily epidermis was shorter than in the other groups. The time devoted to the teacher introduction and to getting the sample was similar in the four teams; teams A1 and A2 spent a shorter time on mounting the slide than A3 and B5; but the biggest differences are found in the process of handling the microscope, focusing etc, which takes 30 minutes in A3, and less than four minutes in B5, and particularly in the combination of observing and drawing, inexistent in A3, and that in B5 takes nearly seven minutes, about a half of the time spent working with the lily sample. It has to be noted that the students from A3 with a very poor slide, had to observe other teams slides (and probably drawings) in order to produce a drawing themselves (which one of them failed to do) as discussed before. On the other side, the better drawings were produced by four students from team B5, who paradoxically spent less time on the overall task; perhaps one of the reasons has to do with the experience acquired working with the first sample, and other reason may relate to the interactions and will be discussed below.

----

figure 1 about here

In summary, it can be said that students were asked to perform an unproblematic task, with a great deal of cookbook, and little of the features which characterize inquiry; they were asked to manipulate, not to investigate. But during a great proportion of the time, they were not on task, not even performing these hand-on activities, but just looking what others were doing or engaged in incidental talk. In some cases, the results that they translated on the worksheets didn't originated in their own samples or observations, but were copied from other students or from other teams. In other cases they were able to do it with the help from other students in the team, which accounts for some of the results in table 3: four students in team B5 (and none from other teams) draw the two cell types with appropriate legend; the three students from team A1 (and none from other teams) estimated the cell sizes. This lead us to the analysis of interactions.

– **Interactions**

In this analysis we took into account, on the one hand the personal interactions: student --- student and teacher --- student, and on the other hand the interactions among teacher or students and other actors like microscope, sample and slides, handouts, textbooks or notebooks. However, in the flowcharts which depict the interactions for each team, figures 2 to 5, only the personal interactions, and the ones with microscope and handouts are represented for the sake of clarity. Interactions among students and sample and slides were quite unbalanced, as seen in tables 2 and 3, being restricted to one or two students in each team.

About the interactions with textbooks, notebooks or other sources of information, which could be assumed that students would use to check, for instance, the features of epidermic and stomata cells, it has to be said that they were virtually lacking. Only in one occasion, in team A3, one of the students took out from his portfolio a notebook, and apparently made an attempt to look for drawings of animal and plant cells, but he just browsed through the papers a few seconds, and then closed it. The episode didn't seem to affect the development of the task.

From the interactions represented in the flow charts, the meaning of the ones related to microscope and handout (handle, observe, read) is straightforward. The meaning of personal interactions is clarified below with some excerpts from transcriptions.

Team A1, time 12'29"

Code	Actor	to	transcript
Q	Teacher	team	Did you change the magnifying?
A	Adela	teacher	Yes

Team A1, time 15'37"

Code	Actor	to	transcript
Q	Adela	teacher	And now, do we have to draw it here?
A	Teacher	Adela	Yes. You have to choose what you see better.
Q	Adela	teacher	Then, we pick the one that we see better
A	Teacher	Adela	Yes.

These excerpts from A1 exemplify typical questions – answers, that in most cases were, like here, of a technical nature: the questions from students about what to do or how to do it; the questions from teacher to make sure that they were following the instructions.

Team A1 time 18'02"

Code	Actor	to	transcript
I	Adela	Angela	You can see some dashes
I	Ana	Ad & Ang	Here, you can see them
			but they are kind of white

Team A1, time 22'40"

Code	Actor	to	transcript
I	Adela	Ana	Look! I am seeing something that goes like that!
			[gestures with hand in a trajectory about 60 degrees]

These excerpts exemplify exchange of information, not as an answer to a question, but as comments that either students or teacher make spontaneously. Some of these exchanges, while handling the sample or mounting the slide, refer to technical questions. During the observation, some of them, like the ones reproduced above, seem to serve to the purpose of making sense of the observations.

Team A2 time 15'00"

Code	Actor	to	transcript
C	Bea	Bibi	Come on! Are you finished?

We have coded as «compel» interactions when one student is getting impatient; trying to impose something on another, or urging her or him to change places at the microscope («Let me see!») etc. Many times these interactions were nonverbal, or short talks accompanied by gestures, like pushing with an elbow.

Team A2 time 16'45"

Code	Actor	to	transcript
I	Belén	team	I cannot see anything
			And if I cannot see...
Q	Bea	Belén	Did't you see it with the other?
			[refers to objective lens]

D	Belén	Bea	Can't you see that this is the small one? It is the one there! [points to handout in her hand]
D	Bea	Belén	But: wasn't it with the other?
D	Bárbara	Belén	How could it be with the small one?
D	Belén	Ba & Bea	This is the second one!

We have coded as discussion exchanges when the students argue with one another, when they are disagreeing. One could expect some of these discussions to be about different interpretations, for instance, about which parts in the slide corresponded to stomata, or if they were not visible at all; about whether was possible to distinguish other elements, nucleus, cell walls, chloroplasts; about the relationship among observations and some theory studied in the previous lessons. But nothing of this happened, and the discussions, like the one reproduced in the excerpt, are about technical procedures: how to get or mount the sample, changing the lens, the skill (or the lack of it) when focusing etc.

The only exchange of a different character takes place in team A1 about how to estimate the cell sizes, when they have to deal with some Mathematical concepts. However it is not coded as «discussion» because there are not different opinions: one person is informing about the procedure to follow and the other two accept it without discussion. What we don't know is whether this two students really understood it, or whether just copied the results from the first one.

Finally we have coded as «talk» either incidental talk, comments about the school not related to the lesson, personal remarks (about hairdo, for instance), or indecipherable or inaudible exchanges.

In the flowcharts the arrows indicate the direction (e.g. who is asking to whom), and thickness of lines give a rough indication of frequency.

About features of the interactions in each team:

In team A1, as seen in figure 2, Ana interacts more with the teacher that the other two students (it has to be taken into account that there are also interactions of the teacher with the team as a group, represented with arrows ending at the frame of the team). Adela has reciprocal interactions with the teacher, while Angela has not individual interactions with the teacher. The personal interactions of the students with one another are quite homogeneous. All three students read from the handout, but Adela handles the microscope with higher frequency than the others.

In team A2, as seen in figure 3, there is little interaction among the teacher and the students. The interactions among students are unequal, with two persons, Bea and Bibi involved in reciprocal exchanges or "sending out", while Barbara and Belén "receive". Besides this Bea and Bibi consult the handouts and handle the microscope more frequently. On the whole it can be said that Bea is leading the group, and this is consistent with the task analysis represented in table 2.

In team A3, as seen in figure 4, there is frequent interaction among teacher ans students, and the analysis of the video shows that this is related to the problems that the students experienced with the samples and slide, and their calls for help to the teacher. The interactions of the three students with persons outside the team are probably also related to these difficulties (a great deal of them were indecipherable). In this team Carlos is interacting more than the other two, both with his colleagues and with the teacher, and he and Castor operate the microscope more frequently than Cesar. The three students read from the handout, Castor with higher frequency. On the whole, Cesar has fewer interactions than the other two.

In team B5, as seen in figure 5, there was a shorter time analyzed, because part of the session was devoted to a different sample. This probably accounts for the total number of interactions being smaller. The teacher interacts with them as a group, or individually only with Damian and Daniel, not with the other two. Del and Denis are the students involved in more interactions, and Del is also the one operating the microscope with higher frequency; Damian doesn't handle the microscope, just observes. Only Damian and Daniel read from the handout. It is perhaps worth noticing that this team had the best performance concerning the drawing of the two cell types.

It is difficult to talk about patterns in the interactions in the four teams. In three cases there are students who apparently are playing a leading role: particularly Bea in team 2, but also Adela in team A1 and Carlos in team A3, while in team B5 there are less differences among students. About the quality of the interactions, it is worth mentioning that in two teams, A1 and B5 there are no exchanges that could be coded as «discuss», and this means that they just exchanged questions and answers, informations and incidental talk. At the same time, these two groups were performing better in terms of the required tasks: team A1 was able to estimate the cell sizes, and four students from team B5 produced drawings of the two cell types with some adequate labels. In our opinion this may correspond to a feature of school culture: the important thing is to get the solution, the answer, the product, and not the process by which it was possible to reach it. So once the conclusion is reached by one student, the others seem ready to accept it without challenge. The question remains about whether this is an authentic «conclusion» for them, in the sense that they understand the logical process leading to it, and would be able to reproduce it with a different instance, or if they just constructed it assigning the category of «conclusion» to data (information) provided by other student.

This lead us to the third objective of our study: the identification of features of the discourse in the Biology laboratory in the school. What could be said about what count as data, background knowledge or conclusions in these sessions? Is it related to the way in which scientists study the natural world? Or does it correspond to the school culture?

From the analysis of the videotapes and students' productions, it seems that the data are their microscope observations. The conclusions that they have to reach are on the one hand the distinction of two cell types (reflected in a labelled drawing) and on the other the estimation of size. In our opinion this task does not involve inquiry as it is unproblematic, but at least it would require to relate the observed with the theory (as taught in previous sessions), from sources such as memory, textbooks or notebooks. We believe that it would also require to relate the observation with the instrument, optical microscope, which imposes certain conditions on the ways this particular piece of nature is observed: for instance samples are seen by transparence, and they need to be very thin; there are different layers in a sample and it is possible to observe only one at a time; there are structures impossible to observe with this instrument, and there are artifacts (like air bubbles) which does not belong to the sample but may be confused with them. The instruments are an important element although for many researchers, and even Philosophers of science, as Bechtel (1996) notes they are a given, and not something which needs to be considered.

This could be illustrated with a discussion of the problems faced by team A3. In fact we interpret these difficulties that the students from team A3 had with their samples as related to a lack of understanding of the way a microscope magnifies and not simply as a lack of dexterity in taking the samples. From the analysis of the videotapes it can be concluded that the teachers didn't refer to the microscope and how it works, to the transparence and the relation among it and the thickness of samples; they just gave technical directions about how to change objectives and how to focus. The students in team A3 took a sample not by peeling a fine layer of epidermis, but by cutting a little piece from the whole lily leaf, in other words mistook size, smallness, for thinness. This sample was not transparent and they couldn't see anything. After several failed observations trough the microscope, they decided to discard the sample and prepare a second one. However, as they didn't understand the nature of the problem, and the teacher told them that the slide was not good, but without reference to the transparence question, they followed the same procedure, and cut out a second little fragment from the whole leaf instead of peeling of the epidermis. This second sample proved as inadequate for observation as the first, and at the very end of the session (34'42") the teachers takes herself a sample and prepares a slide for them, which Carlos and Cesar try to observe, while Castor goes to see the slide from other team.

What count as conclusions in these sessions are on the one hand the distinction among the two cell types, and on the other the estimation of the cells size. The move from data to conclusions is not related to background knowledge, for instance in the first question to the function of stomata or even to the features of plant cells. There are no judgements about one conclusion: when a student reaches it, the others seem ready to accept it without discussion. There was only one team, A1, which estimated cell sizes, and again their exchanges about this question do not relate the problem or observation with background knowledge (either cell sizes or features of the instrument); at the beginning they apparently do not realize that they are seeing the cells bigger that they actually are, so their first move is to multiply the observed size by the magnifying. Following a kind of «socratic dialogue» among the teacher and Adela, the student realizes that she has to divide, not multiply, in order to estimate the actual size, and then her results are copied without discussion by the other two students.

Part of the activities performed could be viewed as "practical Biology", but others, such as observing other students, changing places, asking rethoric questions, and in our opinion, even having a quick glance through the ocular without time to focus, could be coded as display, as "acting as students" but, as Bloome et al (1989) define it, with little relation to the development of intended concepts or skills.

5 Conclusions and implications

The overall development of the sessions in the four teams studied offers, in our opinion, an instance of what Brown et al (1989) call archetypal school activities framed in school culture rather than authentic science practice.

This opinion is related on the one hand to the nature of the task, unproblematic, and that simply asks students to follow directions. On the other hand, the performances of students and their interactions seem to show that for them the goals of the task are to get an «answer», a solution, something to write in their reports, and not to understand or judge the process by which the answer is reached. This would be quite opposite to the development and use of logical forms and explanatory accounts referred to by Connelly (1972) when defining inquiry in Biology. We think that both following instructions, and the pressure to finish the task (as soon as possible) are features of school culture. The performances and interactions of students do not relate to theories, to background knowledge, they are not talking science (Lemke 1990), the classroom talk being on the contrary what Duschl terms as «epistemologically flat».

In our opinion, at least in the teams studied, there is a gap between the opportunities that lab work should provide for developing knowledge, and the activities actually performed by students. We believe that a different approach is needed, in which it should be explicit not just "how" to do the tasks, but also "why", and "for what purpose". Our proposal is to engage students into inquiry in authentic problems, which would catch their attention (motivation), engaging them in the tasks, and which would ask for planning, hypothesizing and relating observed data to background knowledge. This is the line we are currently exploring, and the preliminary results of a task designed with this inquiry perspective (Jiménez & Díaz 1997) with students striving to find the adequate knowledge to frame their observations and hotly discussing their interpretations, seem to indicate that it is possible to change the laboratory work in Schools.

In other words, the features observed in these sessions are not intrinsic to laboratory activities, nor should work with the microscope lead to a particular view of science, for instance one that is detail-oriented. It is a question of curriculum design and we agree with A. Brown (1992) about the need in aiming for Hawthorne effect in the classroom, in terms of increased student control of their own learning and satisfaction. The problems involved in designing laboratory activities in an inquiry perspective are not easily solved, but there is an expectation that its exploration through classroom study will lead to an increased understanding of how High school students learn Biology and in which conditions are they able to apply this knowledge.

Acknowledgements: This paper is based on work supported by the Spanish Direccion General de Investigación Científica y Técnica (DGICYT), grant PB 94-0629.

References

Bechtel W. 1996 Discovering discovery. Invited address at the annual meeting of NARST, St. Louis, April 1996.

Bloome D., Puro P. & Theodorou E. 1989 Procedural display and classroom lessons. *Curriculum Inquiry* 19 pp 265 - 291.

Brown A.L. 1992 Design Experiments: theoretical and Methodological Challenges in creating complex interventions in classroom settings. *The Journal of the learning Sciences* vol 2 pp 141 - 178

Brown J. S., Collins A. & Duguid P. 1989 Situated cognition and the culture of learning. *Educational Researcher* 18 pp 32-42.

Connelly F.M. 1972 Liberal Education in Biology: an Inquiry Perspective. *American Biology Teacher* 34 (7) pp 385-388, 391.

Connelly F.M., Finegold M., Clipsham J. & Wahlsrom M. 1977 *Scientific Enquiry and the Teaching of Science*. The Ontario Institute for Studies in Education.

Cunningham C. 1996 Knowing and Teaching about Science: Teachers' sociological Understanding of Science. Paper presented at the annual meeting of NARST, St. Louis MO, April 1996.

Díaz de Bustamante J. & Jiménez-Aleixandre M.P. 1997 Interpretation and drawing of images in Biology learning. In Bayrhuber H. (ed) *Research in Biology Learning. Proceedings of an International Conference*. I.P.N. monographs. Kiel: I.P.N. (in press)

Duschl R.A. & Gitomer D. H. 1996 Project Sepia Design Principles. Paper presented at the annual meeting of AERA, New York, April 1996.

Hodson D. 1986 Rethinking the role and status of observation in Science Education. *Journal of Curriculum Studies* 18 (4) pp 381-396.

Hodson D. 1994 Hacia un enfoque más crítico del trabajo de laboratorio. *Enseñanza de las Ciencias* 12 (3) pp 299 -313.

Jiménez-Aleixandre M.P. & Díaz de Bustamante J. 1997 Plant, animal or thief? Solving problems under the microscope. Paper presented at the European Science Education Research Association (ESERA) Conference, Roma.

Kelly G.J. & Crawford T. 1996 Looking for science in the everyday life of a classroom. Paper presented at the annual meeting of NARST, St. Louis, MO, April 1996.

Latour B. & Woolgar S. 1986 Laboratory life. The construction of scientific facts. N.J. Princeton University Press.

Lemke J. 1990 *Talking Science. Language, learning and values*. Norwood, N.J.: Ablex.

National Research Council 1996 *National Science Education Standards*. Washington D.C.: National Academy Press.

Tamir P. & García M.P. 1992 Characteristics of laboratory exercises included in science textbooks in Catalonia (Spain). *International Journal of Science Education* 14 (4) pp 381-392.

Wandersee J. H. 1996 The graphic representation of Biological Knowledge: integrating words and Images. In Fisher K. & Kibby M. (ed) *Knowledge acquisition, organization and use in Biology*. Berlin: Springer Verlag

1. PROBLEMS • Posing questions • Proposing problems
2. RELATING PROBLEMS TO THEORY • Framing problems • Identifying assumptions • Examining books and other sources of information
3. INVESTIGATIONS: plan and data collection • Proposing hypothesis in light of theory • Planning • Making decisions about procedures, courses of action • Using tools to gather data
4. INVESTIGATIONS: data analysis • Using tools to analyse & interpret data • Proposing answers, explanations, predictions • Considering alternative explanations
5. RELATING DATA TO THEORY • Reviewing what is known in light of experimental evidence • Reaching a conclusion and supporting it with arguments • Using critical and logical thinking
6. COMMUNICATING THE RESULTS • Assessing arguments for different explanations • Using different notational systems

Table 1 Activities involved in inquiry

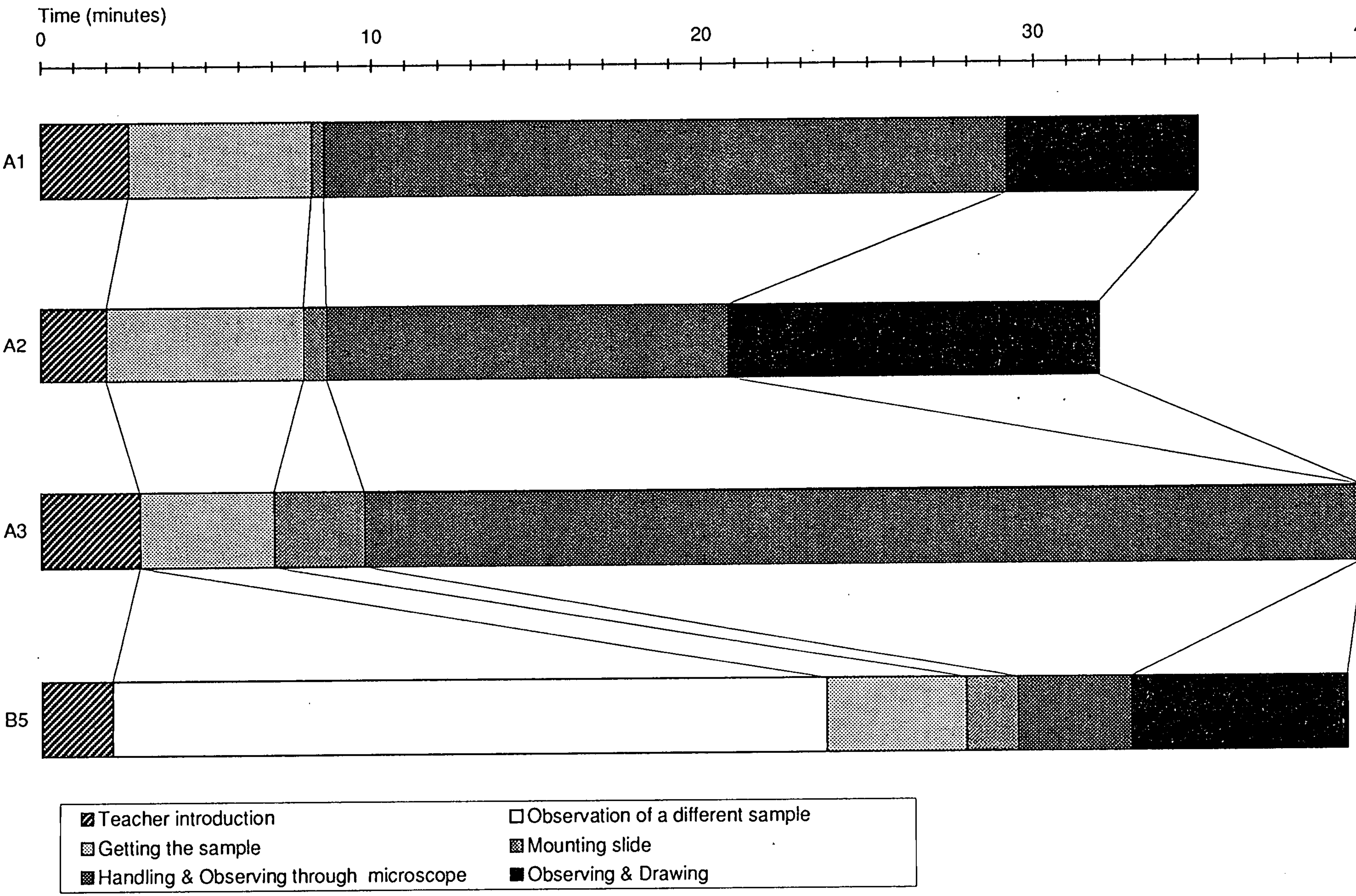
students activity / time	Barbara On task	nº	Bea On task	nº	Belen On task	nº	Bibi On task	nº
Pays attention to teacher	152 s	3	220 s	5	222 s	4	244 s	5
asks or answers teacher	14 s	1	8 s	1	-	-	-	-
reads handout	85 s	2	138 s	5	25 s	1	254 s	7
getting the sample								
tries to peel it	-	-	4 s	1	125 s	2	-	-
peels it	-	-	-	-	-	-	-	-
cuts it	-	-	-	-	-	-	7 s	1
mounting the slide								
Drops water in slide	-	-	25 s	1	-	-	-	-
Dries excess of water	-	-	53 s	1	-	-	-	-
Places sample on water	-	-	16 s	1	-	-	16	1
Covers sample	-	-	27 s	1	-	-	-	-
Handling the microscope (indeterminate)	-	-	62 s	2	12 s	1	58 s	3
Situating slide in the middle	-	-	4 s	1	-	-	8 s	1
Changing objective	-	-	20 s	1	-	-	-	-
Focusing	12 s	1	94 s	3	16 s	1	36 s	2
Observing through the microscope (total time)	70 s	13	213 s	21	268 s	31	145 s	10
mean time for each observation	5.4 s		10.1s		8.6 s		14,5 s	
Draws or takes notes	303 s	7	363 s	8	155 s	3	153 s	4
Compels other student	-	-	28 s	3	-	-	-	-
Answers, questions, discusses with or explains to others	268 s	7	173 s	8	309 s	12	185 s	6
Looks what others do	681 s	26	301 s	16	380 s	18	518 s	26
Out (goes, changes place...)	144 s	6	145 s	6	120 s	7	166 s	5

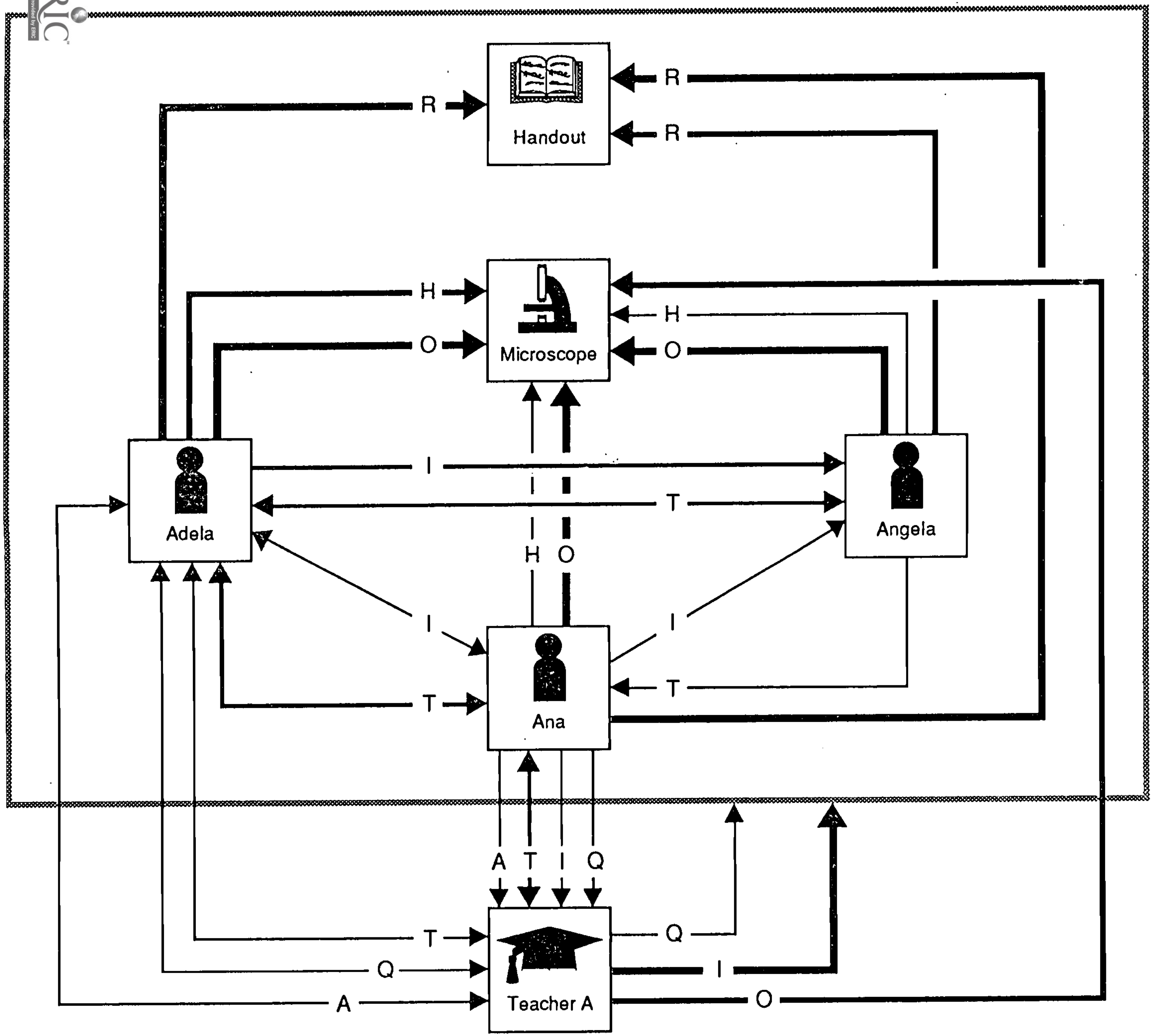
Table 2. Summary from the video analysis, team A2 (1920 seconds = 32 minutes)

Students activity / teams	A1 N=3	A2 N=4	A3 N=3	B5 N=5
getting the sample	2 students	1 student	1 student	2 students
mounting the slide	1 student	1 student	2 students	2 students
placing slide / focusing	1 student	1 student	2 student	1 student
observing through the microscope	from 4'32" to 1'51"	from 4'28" to 1'10"	from 7'48" to 1'55"	from 59" to 25"
drawing	# students	# students	# students	# students
the two cell types with labels				4
the two cell types without labels	1	1	2	1
one cell type with labels		1		
one cell type without labels	2	1		
doesn't deliver the worksheet		1	1	
estimating the cell sizes	# students	# students	# students	# students
estimates it	3			
indicates magnifying ex 4 x 15		2	2	
no indication		1		5
doesn't deliver the worksheet		1	1	

Table 3 Number of students performing each activity required in handout

Figure 1. Timeline of activity segments for the teams





Legend

A answer
C compel
D discuss
H handle
I inform
O observe
Q question
R read
T talk

inside group
outside group

Figure 2.- Interactions in A1

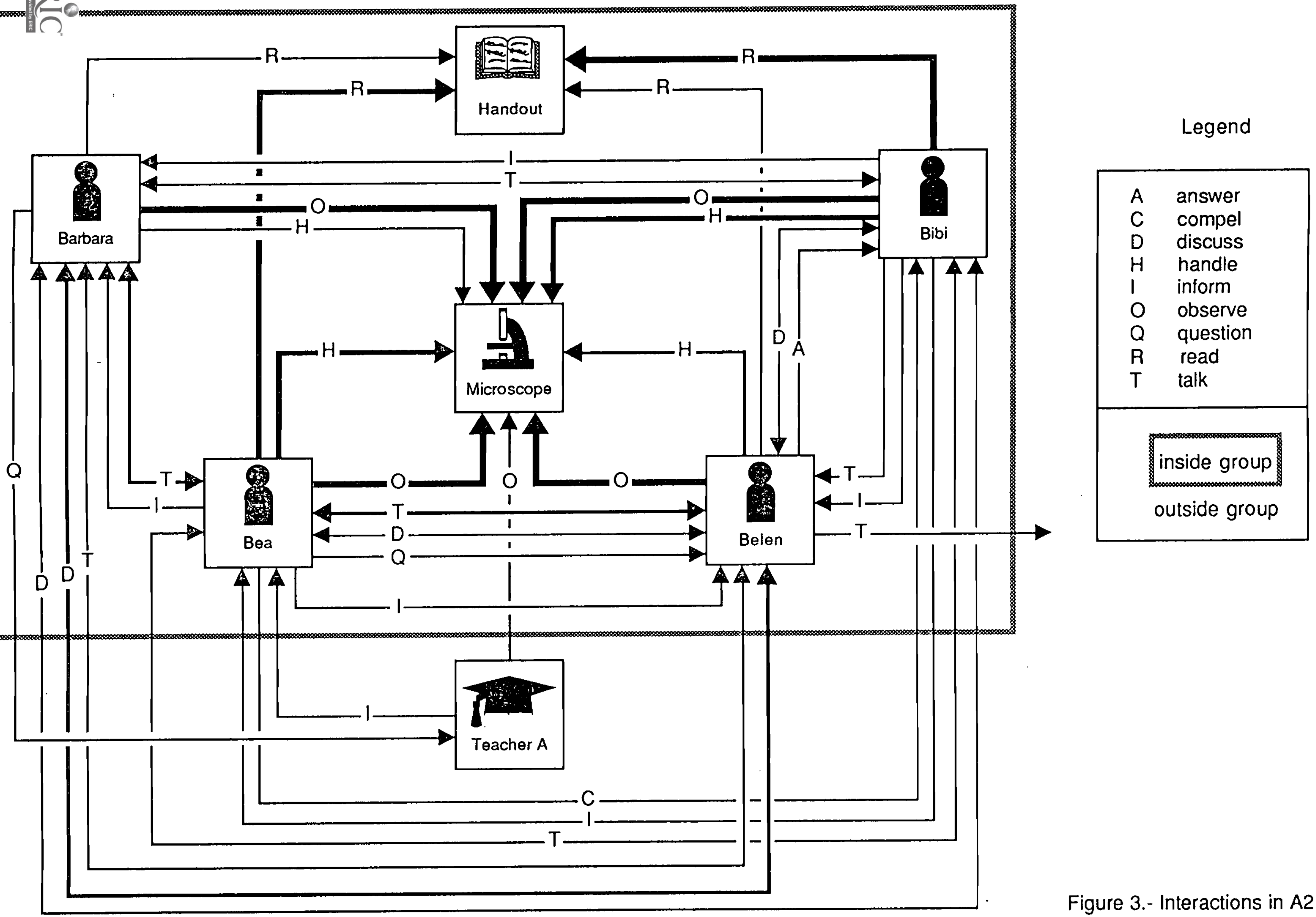


Figure 3.- Interactions in A2

BEST COPY AVAILABLE

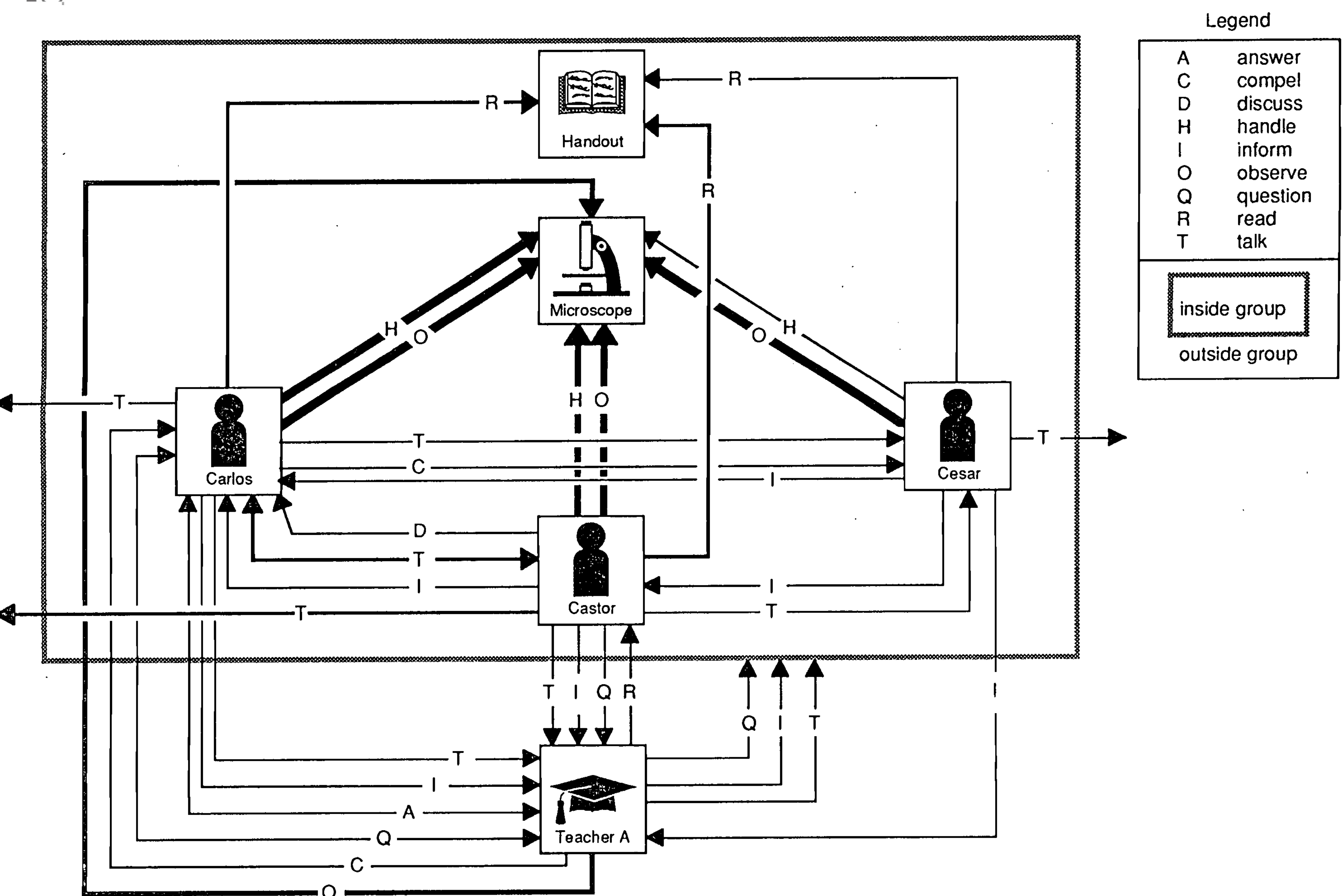
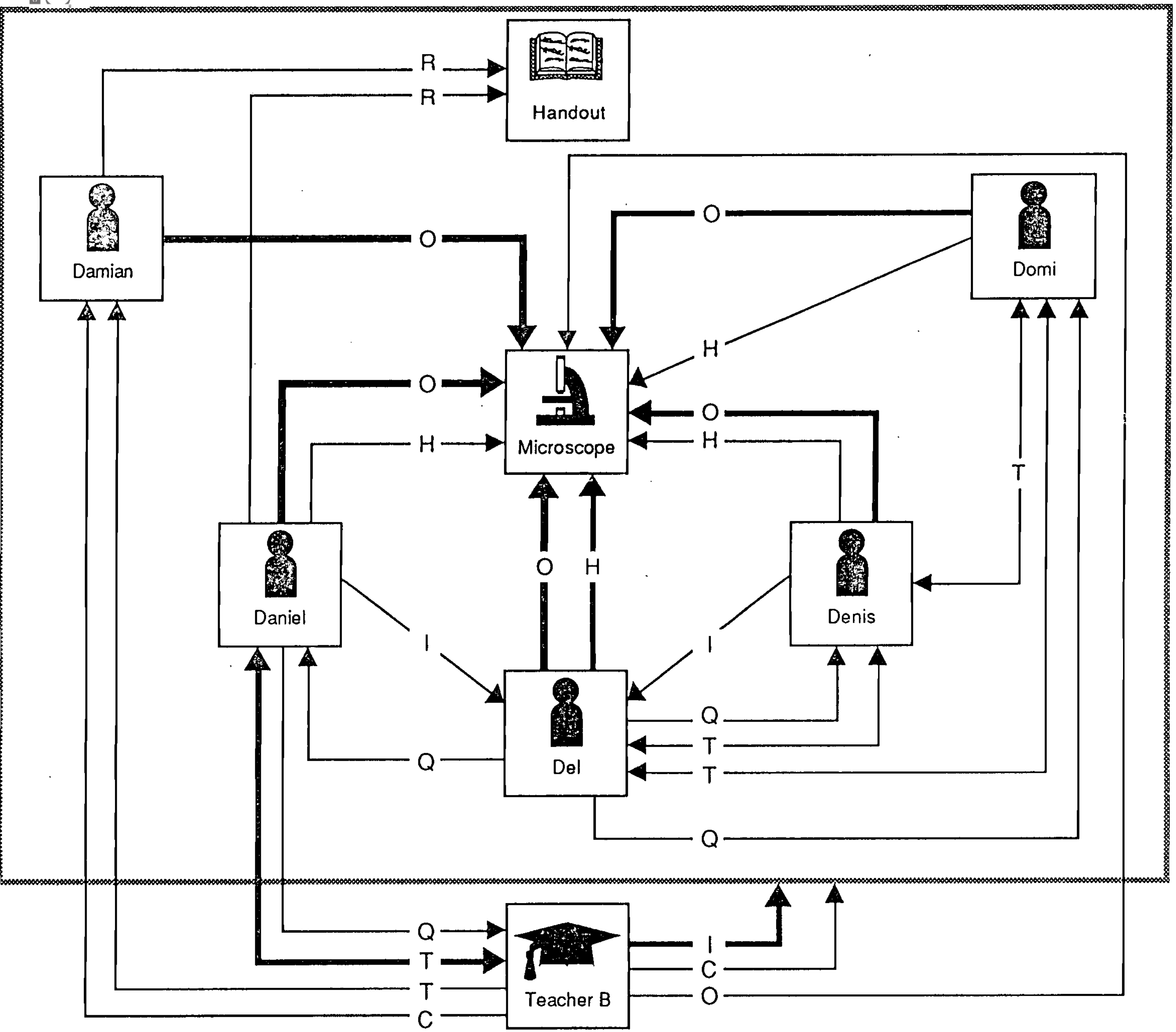


Figure 4.- Interactions in A3



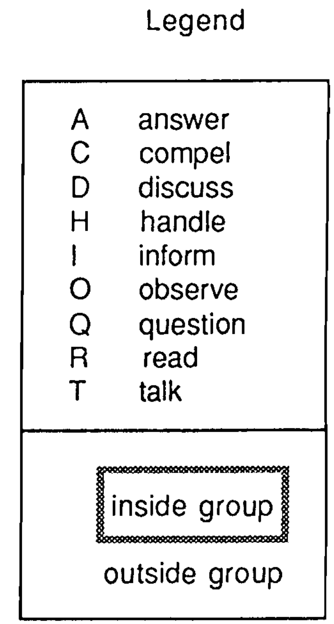


Figure 5.- Interactions in B5

AREA 1997

SE060199

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement (OERI)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: ANALYSING CLASSROOM DISCOURSE: PRACTICAL WORK IN THE BIOLOGY LABORATORY	
Author(s): JIMÉNEZ-ALEIXANDRE, María-Pilar & DÍAZ de BUSTAMANTE, Joaquín	
Corporate Source: Dpt. DIDÁCTICA DAS CIENCIAS UNIVERSITY of SANTIAGO de COMPOSTELA - SPAIN	Publication Date: MARCH 24, 1997

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic/optical media, and sold through the ERIC Document Reproduction Service (EDRS) or other ERIC vendors. Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce the identified document, please CHECK ONE of the following options and sign the release below.

[X] **Sample sticker to be affixed to document**

Check here

Permitting microfiche (4"x 6" film), paper copy, electronic, and optical media reproduction

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Level 1

Sample sticker to be affixed to document [ ]

or here

Permitting reproduction in other than paper copy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN OTHER THAN PAPER COPY HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Level 2

Sign Here, Please

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but neither box is checked, documents will be processed at Level 1.

"I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce this document as indicated above. Reproduction from the ERIC microfiche or electronic/optical media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries."

Signature:	Position: HEAD of DEPARTMENT
Printed Name: María Pilar JIMÉNEZ-ALEIXANDRE	Organization: UNIVERSITY of SANTIAGO - SPAIN
Address: Dpt. DIDÁCTICA das CIENCIAS UNIVERSITY of SANTIAGO de COMPOSTELA Av. XOAN ~~XXIII~~ 15704 SANTIAGO de COMPOSTELA - SPAIN	Telephone Number: (34) 81-56.31.00 ext 12005
	Date: Chicago, 24 March 1997

OVER

CUA

THE CATHOLIC UNIVERSITY OF AMERICA
Department of Education, O'Boyle Hall
Washington, DC 20064
202 319-5120

February 21, 1997

Dear AERA Presenter,

Congratulations on being a presenter at AERA[1]. The ERIC Clearinghouse on Assessment and Evaluation invites you to contribute to the ERIC database by providing us with a printed copy of your presentation.

Abstracts of papers accepted by ERIC appear in *Resources in Education (RIE)* and are announced to over 5,000 organizations. The inclusion of your work makes it readily available to other researchers, provides a permanent archive, and enhances the quality of *RIE*. Abstracts of your contribution will be accessible through the printed and electronic versions of *RIE*. The paper will be available through the microfiche collections that are housed at libraries around the world and through the ERIC Document Reproduction Service.

We are gathering all the papers from the AERA Conference. We will route your paper to the appropriate clearinghouse. You will be notified if your paper meets ERIC's criteria for inclusion in *RIE*: contribution to education, timeliness, relevance, methodology, effectiveness of presentation, and reproduction quality. You can track our processing of your paper at http://ericae2.educ.cua.edu.

Please sign the Reproduction Release Form on the back of this letter and include it with **two** copies of your paper. The Release Form gives ERIC permission to make and distribute copies of your paper. It does not preclude you from publishing your work. You can drop off the copies of your paper and Reproduction Release Form at the **ERIC booth (523)** or mail to our attention at the address below. Please feel free to copy the form for future or additional submissions.

Mail to: AERA 1997/ERIC Acquisitions
The Catholic University of America
O'Boyle Hall, Room 210
Washington, DC 20064

This year ERIC/AE is making a **Searchable Conference Program** available on the AERA web page (http://aera.net). Check it out!

Sincerely,

Lawrence M. Rudner, Ph.D.
Director, ERIC/AE

---

[1]If you are an AERA chair or discussant, please save this form for future use.