NEW DIRECTIONS IN MATHEMATICS AND SCIENCE EDUCATION

Staging & Performing Scientific Concepts

Lecturing is Thinking with Hands, Eyes, Body, & Signs

Lilian Pozzer Ardenghi and
Wolff-Michael Roth

SensePublishers

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Scope

Mathematics and science education are in a state of change. Received models of teaching, curriculum, and researching in the two fields are adopting and developing new ways of thinking about how people of all ages know, learn, and develop. The recent literature in both fields includes contributions focusing on issues and using theoretical frames that were unthinkable a decade ago. For example, we see an increase in the use of conceptual and methodological tools from anthropology and semiotics to understand how different forms of knowledge are interconnected, how students learn, how textbooks are written, etcetera. Science and mathematics educators also have turned to issues such as identity and emotion as salient to the way in which people of all ages display and develop knowledge and skills. And they use dialectical or phenomenological approaches to answer ever arising questions about learning and development in science and mathematics.

The purpose of this series is to encourage the publication of books that are close to the cutting edge of both fields. The series aims at becoming a leader in providing refreshing and bold new work—rather than out-of-date reproductions of past states of the art—shaping both fields more than reproducing them, thereby closing the traditional gap that exists between journal articles and books in terms of their salience about what is new. The series is intended not only to foster books concerned with knowing, learning, and teaching in school but also with doing and learning mathematics and science across the whole lifespan (e.g., science in kindergarten; mathematics at work); and it is to be a vehicle for publishing books that fall between the two domains—such as when scientists learn about graphs and graphing as part of their work.

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PREFACE

The philosopher Jacques Derrida has emphasized throughout his entire career that Western cultures are logocentric, that is, they privilege language (Gr. *logos*) and the forms of thought or logic (Gr. *logos*) that come with it. Over the years, this form of logic has been male-oriented and male-dominated, which has led Derrida to suggest that Western philosophy and epistemology have been not only logocentric but in fact phallogocentric. The logocentric orientation of the scholarly literature can be seen in the fact that anything expressed in a communicative mode other than language tends to be translated into language without sufficient attention to the question about the degree to which the translation changes, distorts, and even falsifies the original expression. The centrality of verbal communication in research work on interaction in science classrooms is hardly arguable; most research is designed to account for verbal interaction only. But lately, more and more researchers are using videotaping in their data collection procedures, which at least affords the possibilities for a multimodal analysis to be performed, although in many cases, it is still the verbal interactions that are prominent and little use is made of the rich nonverbal, visual data collected.

In this book, we present a different approach to analyzing communication during science lectures, taking the nonverbal aspects of communication and interaction to the forefront of the analytical work. Thus, beyond the specific contributions that the findings of each study present for the science education community, there is also a presentation of methodological frameworks and analytical procedures that are of interest for researchers who are attuned to the multimodal nature of classroom interaction but may be overwhelmed by the complexity of the task. As a result of our analyses, we have come to the conclusion that science concepts are more than what lecturers can say and write on the board. Science concepts cannot be abstracted from their complex performances. To understand these performances, we need to take into account the body, how it is placed in and moves across space, its orientation, its movements (gestures), the aspects of the setting it marks (e.g., the diagrams that it makes salient), and other resources including prosody (e.g., pitch, speech volume, speech rate).

Over the years, we conducted a substantial number of studies concerning the communication of science during lectures. This book brings together what we have learned through our research that focuses on the use of gestures and body movement within the context of science teaching. It presents analyses that encompass over a decade of research work, conducted at the University of Victoria, in Victoria, British Columbia, Canada. This research is part of a research program, which has been extensive in the area of science education and has included research work on gestures, embodied cognition and inscriptions, three topics that permeate the chapters in this book. We draw on previously published papers, which we have substantially revised for inclusion in this volume. These papers have been published in journals across a variety of disciplines, not necessarily accessed by science educators, including

the *Journal of Pragmatics*, *Journal of Research in Science Teaching*, *Language & Society*, *Linguistics and Education*, *Pedagogies: An International Journal*, *Science Education*, and *Semiotica*.

Finally, we acknowledge and thank the people that made the work reported in this book possible: the teachers and lecturers who opened their classrooms to us, and the school staff and administration personnel that granted us access to the schools in the first place; the students who kindly assented to participate in the studies we developed, enduring the many days of videotaping and intrusion in their daily school activities, and their parents, who consented to their children's participation in the research projects; and also our colleagues who co-authored original versions of the studies that are reported in three of the chapters in this book: Daniel Lawless, G. Michael Bowen, and Kenneth Tobin. We also thank the Social Sciences and Humanities Research Council of Canada, for financial support for the research projects that originated the studies reported here.

Montreal and Victoria
January 2010

INTRODUCTION

THEORETICAL AND EMPIRICAL GROUNDING

Communication is at the core of social interaction, which makes it a topic of interest in different disciplines, including science education and especially as it pertains to teaching and to student–teacher interactions in classrooms. Most research on classroom communication and interaction, however, employ a language-centered approach to communication, in which verbal forms are considered to constitute a formal system that can be studied in isolation from other social phenomena. Moreover, what individuals say tends to be taken as an articulation of thought that exists independent of its expression. To use an analogy: what people communicate is taken like a computer printout by means of which the contents of the memory are made available to the user. There is a direct equivalence between the content and structure of the computer memory and the content and structure of the printout. Phenomenological studies, however, point out that the body *is* a form of expression and therefore, is a form of thought. Gestures studies, especially in psychology and anthropology, argue for the inseparability of speech and gestures and the need to include the *context* into the analysis of language and communication. The sociocultural and historical context of classroom interactions has been included in analysis of classroom discourse for at least the past two decades. Most analyses, however, still are centered on the verbal aspects of discourse and other contextual aspects of communication and interaction, such as its material and nonverbal aspects. These aspects have been less frequently addressed in research on science teaching and learning. Thus, although lectures are considered social interactive phenomena, they have not yet been widely acknowledged as communicate events that mobilize a large variety of resources that can be used to mark, re-mark, and remark sense.

LECTURES AS SOCIAL INTERACTIVE PHENOMENA

Lectures remain a pervasive means of teaching science at all levels of schooling. Traditionally, lectures have been investigated solely or primarily from a perspective in which spoken and written language constituted the means of acting and interacting in the classroom. Although a lecture may be equivalent to a monologue in certain situations, it always involves a variety of nonverbal actions and material resources that also constitute semiotic (sense-making) resources and that are all integrated into the same unit. Each semiotic resource has a repeatable dimension, which, in the case of words, is the dictionary sense. Each semiotic resource also has a non-repeatable dimension, which is its situational use and adequacy, for which the term *theme* has been proposed (Bakhtine [Volochinov] 1977).

INTRODUCTION

Lectures are part of the societal activity of schooling. Here, they constitute part of the task system and present 'patterns of organization, a structure' (Lemke 1990, 2). The success of lectures as a moment of the societal activity of schooling requires the participation of teacher and students, the members to the setting. These members to the setting have to collaborate and collude to produce lectures as recognizable events. In this sense, therefore, lectures are interactive events, even when we take into consideration the primacy of the teacher's actions over the students' in organizing the interactional space of the lesson. Teachers do not talk for themselves but rather address specific audiences. Inherently, therefore, the talk has to be presupposed as making sense. Each word, each communicative act, belongs to speakers and their audiences (Bakhtine [Volochinov] 1977). The language used, therefore, has to be analyzed as a phenomenon that is not particular to this or that teacher but in fact, as a possibility of teaching-learning situations involving members of the culture generally. This culture may be that involving seventh-grade general science students and their teachers, twelfth-grade biology students and their teachers, or third-year university physics students and their physics professors. Our primary phenomenon therefore consists of communicative forms that belong to speakers and audiences. This primacy is itself an outcome of teacher' and students' actions and interactions, and the teachers' performances as lecturers are examples of a member's accountable practice, a through and through practical achievement. In this book, we analyze lessons as multimodal, interactive phenomena, in which movement, speech, gestures, material resources (such as diagrams drawn on the chalkboard), and written language are integrated to form an indivisible dialectical communicative unit.

THE COMMUNICATIVE UNIT

Central to the debate concerning *context* is the nature of the relationship between speech, gesture, and other semiotic resources that speakers produce, and the context that co-participants inhabit and which they contribute to make. It has been proposed that gestures and speech are related dialectically, each constituting a realization of some whole unit but doing so in very different, one-sided form that is irreducible to the other (McNeill 2002). That is, a word and a gesture may both denote the same communicative unit, but each does so in a way that is characteristic and special. A gesture therefore *never* has an *exact* equivalent in a word. This has two consequences. First, there has to be a unit that includes speech and gesture mutually constitutive parts. Both dialectical materialist psychology and phenomenology propose a constitutive, internally differentiated unit that is never self-identical. Second, because speech and gesture are both identical (i.e., concrete realization of sense) and non-identical (i.e., they constitute two different modalities, with diverse characteristics), there is a contradiction, which leads to an instability of imagery (gesture) and language (speech) that propels thought and communication forward. Thus, the different semiotic resources produced as part of a communicative act and, in fact, all the semiotic resources available at a single moment in time, mutually presuppose and

constitute one another: they stand in a dialectical relationship. Forms of sense are marked and remarked and therefore become salient figure when one or more of these resources change simultaneously.

The position McNeill develops is grounded in the work of Lev Vygotsky (1986), who theorizes the relation of thought and language. Accordingly, both thinking and speaking are considered developing processes that mutually influence each other. The two are but one-sided expressions of a higher order unit that is denoted by the term 'word meaning'. 'Word meaning' is not something attached to words but rather a process. Any instant-to-instant development of the two processes is contextualized by the current state of the ontogenetic development of the speaker and by the historical situation of the culture. It is evident that a child speaks and thinks differently from an adult. Less so attended to is the fact that speaking and thinking change as culture and language change in the course of history. Thus, a few decades ago, different forms of language were available to the members of North American societies, which means that they were both describing experiences differently and have had a different self-understanding than the members of the same societies living today.

Here we understand word-meaning as the intuitively and practically constituted coherence of familiar everyday situations. Any sign, word, or other semiotic resource accrues to an existing totality of significations (Heidegger 1996). Because of some inherent problems with the English word and concept 'meaning' and its relation to concepts in other languages and theories, we refrain from using the term. Instead, we use the terms 'sense', 'reference', and 'signification', which have better equivalents in the languages of the theorists and philosophers that we draw on in this book. We can think of Vygotsky's 'word-meaning' as the situated signification of a word, which is the non-iterable, once-occurrent *theme* that the word denotes (Bakhtine [Volochinov] 1977). The iterable part of the word is its *sense*, which generally is provided in dictionaries. That is, whereas a word tends to have a delimited number of senses in which it can be employed, iterable across situations, there is a non-iterable, singular aspect to word use, which Bakhtin captures with the concept of theme.

The pragmatic aspects of the communicative act simultaneously produce and frame the existing semiotic resources to constitute the communicative unit. As a consequence there is an interplay of a variety of different semiotic resources, some existing in the setting, others being produced, all of which nevertheless mutually presuppose each other within and constitutive of what we know as sense. Interlocutors mark and re-mark sense in such a way that the respective other may also remark it. To understand what a person is constituting as communicative figure, that is, to mark and re-mark sense, we need to take into consideration all the resources that constitute the unit in its entirety rather than focusing only on its one-sided expression in speech, gesture, and the other semiotic resources.

In extension of the work previously discussed, we consider not only language but also anything else that human bodies produce to mark, re-mark, and remark sense in a particular situation. That is, anything that becomes a resource to communication is taken into account as integral to communication. Such resources include, for

example, pointing (deictic) and descriptive (iconic) gestures, prosody (e.g., speech volume, speech rate, pitch), body orientation, and body position. As we show throughout this book, these other aspects are central to communication and, in a strong sense, cannot be reduced to language. We take these resources as one-sided articulations of a larger communicative whole the sense of which is a function of the societally organized and motivated settings in which the relevant communicative exchanges take place.

We suggest that sense and signification are neither simply distributed across each one of these modalities nor the sum total of these resources. Rather, the sense of a communicative act arises from the dialectical (mutually presupposing and mutually constituting) relation among all these perceptually different (hence, non-identical) semiotic resources. Although each modality may function best to present one type of information (or, alternatively, to present information in one specific manner), no one of these modalities carries sense in isolation from the others, and, as such, no one should be investigated as a modality in isolation from the other modalities. This view is also congruent with modern takes on multimodality that focus on the complete action instead of the role of individual, isolated modalities within social interaction. Throughout this book, we aim at articulating and analyzing the entire communicative unit, comprised of different (non-identical) resources that are dialectically related to each other and pertain to the same referent (hence, identity of non-identical entities), and which the teachers/lecturers use for publicly articulating scientific concepts to make resources available for understanding and learning. The teaching of scientific concepts, from this perspective, is a complex performance requiring and producing multiple resources of very different nature.

EMBODIED COMMUNICATION AND INTERACTION

In taking into consideration the communicative unit as a whole, we begin with the fundamental assumption that language—in the sense of the Saussurian *parole* (language as spoken) as distinct from *langue* (language as a stable, formal, and synchronic system)—is only one aspect of the broader phenomenon of human communication. In fact, at its very heart, language is based on the production of sounds that we have learned to hear in particular ways. Viewed from this perspective, language is as material as are gestures, body positions, markings on a chalkboard, and all the other resources that interlocutors produce to mark and re-mark sense.

Communication is not as rational as a printout from computer. It is produced in real time and comes with all the features that unedited real-time production comes with. Thus, close analysis of everyday talk in formal and informal settings shows that the sense of utterances by themselves is underdetermined. Everyday talk (*parole*) is full of 'mumbles, stumbles, malapropisms, tics, seizures, psychotic symptoms, egregious stupidity, strokes of genius, and the like' (Rorty 1989, 14) that listeners need to adjust to in order to make sense of what it is the speaker is talking about. However, in communicative encounters, speakers (and listeners) make available to each other many other resources that provide contexts for constraining

the sense of words. These resources are fundamentally grounded in the fact that human speakers have bodies: various forms of movements with different parts of the body provide cues on how to understand just what is being said by delimiting the range of possible interpretations. The body is so important to marking and re-marking sense in speech situations that there is a greater likelihood of communicative breakdown and need for conversational repair if visual access is barred or mediated by some technology.

Body movements and gestures allow interacting individuals to coordinate their expectations and, thereby, develop and maintain a smooth running of the encounter. In this sense, the body position or spatial arrangement of the speaker and listeners provides different affordances and constraints to the interaction, and therefore also functions as resource for marking, re-marking, and remarking sense. The way in which interacting participants are orientated to each other and to material artifacts in the room allows for the availability of different types of resources for making sense.

GESTURES

Gestures, a subset of body movements, have become a topic of research in their own right. This is largely because gestures have come to be recognized as a central feature in human communication and across cultures. Gestures are also the most frequent non-spoken form of communication in teaching (Goldin-Meadow 2004), and they constitute the primary means through which integration of all the other resources that form the communicative (ideological) unit during teaching occurs. Gestures and body orientations connect all the various resources concomitantly used to teach scientific concepts, which are, therefore, distributed into the various modalities employed. Moreover, anthropological studies suggest that gestures are not *just* aspects of communicative acts but that they are deep features of cognition (Haviland 1993). Microgenetic studies in school science laboratories confirm that some gestures emerge from the manipulation of objects, movements that later reappear as iconic gestures when students are asked to describe and explain what they have done and observed.

Gestures studies have been traditionally developed in psychology and anthropology. In education, however, few studies investigating the use and function of gestures have been conducted, even fewer in the particular field of science education (for a review see Roth 2002). However few, these studies provide evidence for how gestures can potentially foster learning. For instance, instructors' gestures carry relevant information, which learners do take advantage of during instruction (e.g., Singer and Goldin-Meadow 2005). Conversely, it has also been demonstrated that teachers make reference to information the students have produced through gestures only (Goldin-Meadow et al. 1999), and that it is also possible to know when a child is ready to learn by observing speech and gestures mismatches in the child's discourse. These results encourage us to assume that gestures are indeed semiotic resources available for the students when learning scientific concepts from classroom instruction.

Spontaneous gestures that denote the relatable sense and accompany speech are denoted by the term *gesticulations*. This type of gesture is characterized by the obligatory presence of speech, as they make sense only in conjunction with the synchronous word(s) uttered. These gestures are non-conventionalized, non-morphemic, and cannot be syntactically combined with other gestures. Gesticulations are usually hand and arm movements that accompany speech. They differ from emblems – the gesture of 'thumbs-up' for 'okay' or the middle finger sticking from an otherwise fisted hand to mark an obscenity) – that have a conventionalized form, and from sign language gestures, which are segmented and analytic, thus presenting linguistic properties. Gesticulations are closely connected to speech production, occurring 'as a succession of enactments whose sequencing is governed by the order of presentation of ideas in the discourse' (Kendon 1980, 223). Moreover, in further evidence to their integration with speech, gesticulations seem to occur more often when speakers talk fluently on a topic they are familiar with, as opposed to a topic that they do not master as well, and they are suppressed together with speech, as in the case of a person stammering.

Gesticulations include beats, deictic, iconic, and metaphorical gestures. Beats are gestures that are void of propositional or topical content, and yet lend a temporal or emphatic structure to communication. They function as interactive gestures, which serve to regulate the coordination of speaking turns, to seek or request a response, or to acknowledge understanding (Bavelas et al. 1995). Deictic gestures are used to point out features in the environment, to indicate directions, or to establish and maintain narrative geographies that become taken as shared so that speakers can make subsequent use of them without employing words. That is, these gestures are used to establish situated linkages between talk, on the one hand, and the physical setting, on the other. Their function is similar to that of words such as 'this', 'that', 'here', or 'there', but they frequently are less ambiguous about where the referent of a word is located. They are also used to establish and maintain abstract spaces during communication (Ochs et al. 1996). Thus, for example, physicists may gesture in the presence of a diagram featuring temperature and magnetization or temperature and entropy (see chapter 8). Although these spaces spanned by the variables temperature and entropy have no equivalent in the natural world, the gestures do have this quality. Temperature–entropy diagrams therefore are like the spaces we know from experience even though they contain abstract quantities.

Iconic gestures are hand/arm movements that bear a perceptual similarity with the phenomenon simultaneously denoted by speech. This perceptual similarity constitutes their communicative strength because of a nearly transparent relationship to the thing they convey, particularly within a narrative event in which they depict co-present concrete objects and events. Finally, metaphorical gestures are like iconic gestures, but they provide a visual expression of abstract rather than concrete objects. Using both hands to shape a ball when talking about knowledge is an example of metaphorical gesture; that is, in this case, knowledge is metaphorically depicted as enclosed entity that can be manipulated. In this book, we show that gestures are not only semiotic resources in themselves, carrying specific

communicative information, but they also play a special role in integrating multiple resources that are co-present in the lecture situation. That is, gestures provide the links between verbal and nonverbal aspects of communication, including various graphical representations used in teaching.

INSCRIPTIONS

There have been a considerable number of studies on gestures in situations where people talk about experiences or retell stories. They tend to sit in empty rooms with bare walls with nothing present other than the camera. In contrast, there have been far fewer studies on gestures in situations where the speaker talks in the presence of a relevant artifact. Among the artifacts that are central to conversations in science, inscriptions are of particular importance. Inscriptions such as photographs, maps, charts, diagrams and graphs are of particular importance to smooth functioning of collective activity among scientists or engineers. The presence of the inscription provides a ground against which scientists 'create an intertextual space in which the identities of scientist-as-subject and constructed-scientific-world-as-object are deconstructed and reconstructed as a single blended entity' (Ochs et al. 1994, 152). That is, scientists can be said to talk and travel through graphical space.

Inscriptions are not only pervasive in scientific conversation but also in textbooks and scientific journal articles. For example, a survey of six high school science textbooks and five research journals in ecology showed that there are about 1.4 inscriptions per page and no statistically detectable difference between the two types of publications (Roth et al. 1999). However, there are considerable differences in the work required by members of the audience across the different situations (that is, during face-to-face communication including inscriptions and when reading a text with inscriptions). When there are only inscriptions and texts, such as in textbooks or scientific journals, it is the work of reading that links caption, main text, and inscriptions. Reading is required to construe the orderly sense of the scientific findings and concepts presented. The text presents particular constraints in terms of its ordering and pedagogic arrangements and therefore constitutes a specification of order of coherence from which emerges the rational visibility of the claimed scientific object. What can therefore be observed is not a co-incident truth between, and interactive stabilization of, text and inscription, but the stable congruence between two organizational classes of materials.

In science lectures, too, inscriptions are abundant. Here, words and gestures provide affordances and constraints to the use of inscriptions, which organize the ensemble of different modalities (visual, verbal) being used to communicate particular scientific content. It is as if the discourse and inscriptions are linked through and coordinated by the gestures and body movements enacted during interaction. But, as we show in this book, not only words and gestures are relevant resources for marking, re-marking, and remarking the sense of inscriptions and parts thereof, but also body position, body orientation, prosody, and other communicative means. Moreover, the inscriptions are not merely entities the sense of which is to be elaborated in communication but they constitute resources for understanding

communication more generally. They constitute other semiotic resources as salient in the situation and therefore do not have a privileged status. Like words, they refer us to a communicative whole, which they contribute to constituting. Inscriptions do not have a sense in themselves. In the same way as all other semiotic resources, they are involved in a network of signification that mutually constitute salient resources all of which denote and constitute the communicative unit.

DATA SETS AND SETTINGS

In this book, we draw on very different databases to show that the phenomena we report and theorize are far from characteristic of individuals. We included research studies that encompass distinct data sets and were conducted in different lecture settings. The first dataset, Mr. J's science class, was used in the studies reported on chapters 1, 2, 7, and 8. It was entirely collected in a twelfth-grade biology course and comprises 26 lessons, each 70 minutes long, totaling over 30 hours of videotaped material. The lessons were videotaped over a period of 3 months, using two camcorders, one focusing on the students and the other on the teacher. The lessons we videotaped in Mr. J's biology class were primarily lectures, even though the classroom was arranged as a laboratory. During lectures, Mr. J, an experienced biology teacher, wrote and drew on the chalkboard, sporadically using the projector and the TV and video equipment; more frequently, Mr. J used artifacts such as 3-D models of body parts and devices that simulated body movements. The topic of Mr. J's biology class was human anatomy and physiology; specifically, the recorded lessons dealt with nervous, circulatory, excretory, and reproductive systems.

The second dataset is comprised of videotaped lessons in a seventh-grade science class. For the two studies included in this book that make use of this dataset (chapters 4 and 5), we use only one particular lesson as an example. In the episodes selected, Ms. M, an environmentalist, lectured the students on the topic of their local watershed. She used many photographs, aerial photographs, and maps as part of her explanation of the concept 'watershed'.

The three remaining data sets include footage from lectures at university settings. The study discussed in chapter 6 includes 39 university-level ecology lectures from a second-year university ecology course. During these lectures, the professor used an overhead projector in a darkened room providing students a clear view of the projected lecture notes and inscriptions, as well as the professor's gestures over and about the content in the overhead projections. The lessons were recorded using a fixed camera positioned at the back of the room, which also provided us with a clear view of the professor and the projected images. We had available videotapes of all lessons pertaining to the course (3 hours per week over a period of 4 months).

The fourth setting (presented in chapter 3) involves the teaching of college level physics in a physical science course designed especially for elementary majors in a state university in the southeastern section of the United States. The class contained 25 students who were elementary or early childhood education majors, or students who, after completing the necessary prerequisites, had expressed a formal intention to become majors in these areas. The lecturer in this study was a full professor with 20 years experience of teaching college physics.

The final dataset is presented in chapter 9, and it derives from a two-year study of knowing and learning in undergraduate physics. This dataset includes all 36 lectures of a third-year university course on thermodynamics, videotaped using a camera positioned at the back of the room. The physics professor had over 40 years of experience teaching at the university level.

OVERVIEW OF THIS BOOK

Throughout this book, we consider speech and gesture as mutually constitutive but irreducible representations of the same communicative unit. We also include in the unit of analysis other semiotic resources speakers make available or point out – body movements, prosody, inscriptions, and other material aspects of the setting. For heuristic purposes, the book is divided in three parts, each one emphasizing a particular aspect of the integration of nonverbal resources into the unit of analysis. Part A presents studies focused on the body as a marker for organization of interactive and communicative spaces in the classroom. Thus, chapter 1 focuses primarily on the teacher's movement in the room. In it, we identify the various different locations in which the teacher stands during a lecture, associating these different locations and the movements back and forth between them with particular pedagogical, interactive, and discursive practices. Thus, when the teacher is closer to students, leaning against students' desks, not only there is more interaction between teacher and students but also the type of discourse used and the activities performed differ from when the teacher stands in front of the chalkboard. Each location where the teacher stands during the lesson, therefore, becomes a resource for sense making and also structures the different activities that constitute the lesson.

Chapter 2 presents a micro-analysis of the verbal, prosodic, and physical markers that help us disambiguate between different narrative spaces, specifically during demonstrations where the speaker refers to someone else's actions and speech. The teacher demonstrates the knee reflex as it would occur if students were being examined in a doctor's office. He uses different locations in the room as well as variations in pitch and intonation and the use of different pronouns to delimit two spaces: the classroom and the doctor's office. In chapter 3, we show that lectures can be understood as rhetorical moves that are performed on a stage. In this chapter, the professor staged Aristotle, natural philosophy, and students' observations and intuitive knowledge in opposition to Galileo, controlled (stacked) experiment, and mathematical inscriptions in the form of numbers, plotted data pairs, and curves. The different parts of the classroom occupied by the professor, coincided with the conceptual differences that he presented. That is, gestures and body positions were characteristically different in the different locations on stage and they coincided with conceptual differences communicated in and through the lecture.

Part B in this book focuses on the use of gestures in the presence of inscriptions, which are abundant in science lessons at all levels of education. Chapter 4 presents a framework for the resources speakers make available to their audience for understanding what the talk is all about, distinguishing three situations according to the

nature of reference to the phenomenon talked about: (a) talk is about phenomenon but mediated by reference to a two-dimensional inscription, (b) talk is about phenomenon but mediated by reference to a three-dimensional inscription, and (c) talk is directly about phenomenon. Associated with these three situations are different body orientations, distances to inscriptions, and types of gestures. In chapter 5, we introduce a categorization of gestures associated with photographs when communicating specific scientific information. The gestures and body positioning over and about the imagery of the photographs render these inscriptions three-dimensional and more closely related to the lived in world, as the referents of the photographs become reified in the classroom environment through both gestures and accompanying words.

Part B closes with chapter 6, which deals with the phenomenon of decalages (i.e., semantic or temporal shifts) in talk and gestures. Normally, gestures and the words that pertain to the same ideological unit occur simultaneously – though during periods of development and becoming familiar in a domain there may in fact be shifts between the conceptual referents of words and the gestures. Thus, when beginners are confronted with communicative acts in which the concepts expressed in words and gestures are shifted, we might expect trouble. These shifts or *decalages* as we call them may constitute constraints for marking, re-marking, and remarking sense of the lesson, especially when there are complex inscriptions present. In all three chapters in Part B, the analysis presented provides a sense for the coordination of talk and gesture during lectures, emphasizing the notion that the 'text' of a lecture does more than just explaining the inscription in providing a literal reading of it. Its intent is to instruct the non-initiated how to read a specific inscription. Thus, the gestures that concur with the text are both over the inscription as well as about the information present in the inscription. Gestures and talk are presented as aspects of the work that make the graphical display come alive as the material production of an exemplifying public thinking with eyes, ears, hands, and words. It is in their mutually constitutive relation that all of these resources mark and re-mark sense so that the student audiences may remark it.

Finally, Part C presents studies that are concerned with sense in the making during lectures. In chapter 7, we introduce examples of the integration of verbal and nonverbal resources during science lectures, taking into consideration an entire ideological communicative unit, composed of words, gestures, body posture and material artifacts. In chapter 8, we present a micro-analytic approach to the development of scientific concepts across consecutive lessons, drawing heavily on semiotics to present the idea of a double signifier, verbal and visual, constituted by both words and gestures; while the former changes through the subsequent lessons, introducing novelty and complexity (in the format of scientific terminology) to the concepts being communicated, the latter provides a stabilization in the format of repetitions (called catchments) that provide continuance and congruency to the lessons. In chapter 9, we show how thought and communication develop together, each influencing the other within the overarching and encompassing ideological unit that both denote in a one-sided

and oblique way. Moreover, we describe how the instant-to-instant development of thought and communication is contextualized by and constitutive of the development of the individual, a development itself contextualized by and constitutive of the cultural-historical development of communication and communicative practices.

PART A

BODY IN SPACE

To introduce this first part of our book, consider the following episode: A teacher positions himself in front of the leftmost corner of the chalkboard and starts to write on it, silently. He finishes writing a few sentences, turns towards the students, steps back and away from the chalkboard, and then points to the area on the chalkboard where he has just finished writing, at the same time that he starts to talk. This situation is typical for many classes, and a closer look at it brings forth a myriad of issues that are directly connected to teaching as a recognizable and stable form of social activity. For instance, the teacher starts the writing on the leftmost corner of the chalkboard, which is a culturally and socially given in Western society; here the chalkboard is seen as an oversized notebook, on which the teacher starts to produce and record the day's lesson. The teacher's strategic position on this side of the chalkboard and his writing on it are aspects that are repeated many times within and across lessons. In this sense, they have become characteristic of teaching; that is, we take for granted what this action is communicating to students, what sense-making resources it makes available, and how it is used to structure the lesson. For example, in chapter 3 we show how by means of his positioning with respect to two chalkboards, a university professor emphasizes the contrast between Aristotelian and Galilean physics, in the way these are conducted (natural observation vs. scientific experiment) and in the outcomes/concepts they produce. Another study concerning teacher positioning in the classroom and the types of discourse also shows significant relationships between group sizes (whole-class versus small group), physical arrangements, focal artifacts, and the participation patterns and contents of discourse (Roth et al. 1999).

In this first part of our book, we introduce body positioning as a resource to create and maintain discursive, narrative, interactive and pedagogical spaces in the classroom. This approach is grounded in our understanding of phenomenology of communication, according to which the body takes up position and constitutes expression (Merleau-Ponty 1986). There is no need to go into the mind because, in human interactions, expressions in public space available to all members to the setting are all that matter for understanding the irreducible whole. In fact, for cultural-historical activity theorists, any higher-order mental function always already has been a social relation – society is in the mind as much as mind is in society. The teacher's physical body, occupying and moving around different physical spaces in the room, delimits abstract spaces that exist in the teacher's discourse, and that consequently are made available as resources for marking, re-marking, and remarking during the lecture. As evidenced in chapter 1, just by standing in a certain location in the classroom, the teacher constrains the possibilities of interaction with students and resources in the room, and these constraints in turn limit the range of discursive and pedagogical strategies that can be used at each given location.

In chapter 2 we present an example of how physical location (that is, different places in the room where the teacher positions himself) can function as a marker for delimiting the space of a demonstration. Together with verbal and prosodic markers, the teacher's body positions are resources that help differentiate the classroom space and the narrative space of the demonstration. In chapter 3, we describe the use of classroom space as a stage on which the contrast between two very different conceptions of the physics of motion comes to be played out. Aristotle's views about motion are marked on a chalkboard on the left wall seen from the students, whereas the present standard version comes to be marked on the chalkboard in the front. Emphasized by the dramatic movements of the professor from one chalkboard to the other, a rhetorical account of the differences comes to be highlighted.

Throughout the three chapters, we observe a reliance of communication on the interaction of the material body and the spatial configuration in which it dwells and to which it gives shape in order to mark and re-mark sense so that students may remark it.

CHAPTER 1

BODY POSITIONING AS LESSON STRUCTURE

Lectures are primarily conceived of as events where one speaker talks for most of the time to a mostly listening audience. In this sense, the words spoken during lectures are the predominant focus of attention, with a close second being the technological resources that nowadays are present in most lectures, such as digital presentations and otherwise digitized information that is projected on a screen. In less technological spaces, words and inscriptions written on white boards and chalkboards may also be of interest. One may also agree that the speaker's gestures and facial expressions are also noticeable and memorable, especially when the speaker is particularly animated.

Independent of the type of lecture environment and speaker, however, other modalities are also present and made available for lecture audiences as semiotic resources, particularly in science classrooms, where lecturing constitutes a pervasive means of teaching. These other modalities may include, for example, various instructional objects (e.g., three-dimensional models, textbook, laboratory equipment), material resources and their configuration in the room (e.g., tables, chairs, boards, and laboratory benches), and body positioning and orientation (the teacher's and the students'). Because teacher and students are agents in the classroom, their possibilities to bodily and discursively position themselves differently during interaction helps structure the lesson in progress. In the classroom the teacher's actions (e.g., movement from one location to another and orientation of his body in particular ways) can be understood only within the context of the lesson. At the same time, these actions realize and structure the lesson and are resources for other actions (e.g., in a question–response pair, the former is a resource for the latter) and the interaction between students and teacher.

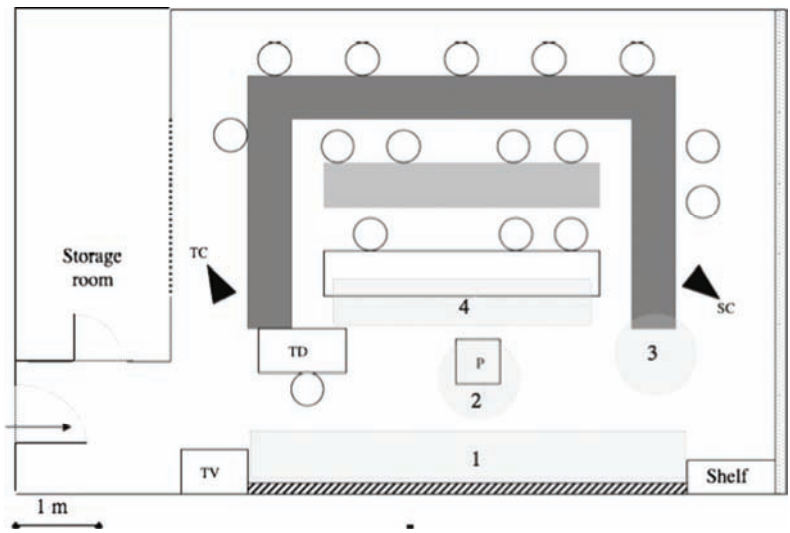
In this chapter, we focus on the opportunities that teachers have for positioning themselves in the classroom to mark and re-mark particularities of conceptual features that they communicate. That is, lecturing includes actions that give structure to and are structured by the lesson. The teacher's body positions in various different locations in the room are associated with pedagogical, interactive and discursive opportunities and practices that unfold during the lesson and constitute semiotic resources that are made available for students in making sense of and participating in the lesson in socially appropriate ways.

A DAY IN MR. J's SCIENCE CLASS

The lesson we present here was culled from Mr. J's biology classes. The chosen lesson is representative of other lessons in Mr. J's science class, in both duration and teaching

strategies and resources used. In this particular lesson, the lecture topic was the respiratory system. As part of his presentation, Mr. J uses a panoply of semiotic resources for marking and re-marking sense including speech, gestures, body positioning and orientation, and the chalkboard (written words and drawings). His teaching strategies involved lecturing and students' paper exercises, as was the case in most of the other lessons.

After recording the time Mr. J spent in different locations in the room, we identified four different general locations, which are represented in Fig. 1.1 (numbered light gray areas in the diagram). Thus, Location 1 is equivalent to the area in front of the chalkboard. Location 2 represents the area around the table in the front of the room. Location 3 is equivalent to the area in the right corner of the room, beside the end of the highest of the student benches, and Location 4 represents the area in front of the lowest (first-level) student bench in the classroom.



LEGEND: Arrow: direction of entrance into the classroom. TV: television set and video equipment cart. Diagonally striped area: chalkboard. Shelf: bookshelf. Storage room: attached room into which a variety of teaching and laboratory materials were stored. Dotted line in storage room right side: opening into the classroom. TD: teacher's desk. FT: table in the front of the room; TC: camera focused on teacher. SC: camera focused on students. Dotted area to the right: wall of windows. Large white rectangle: student bench located in the first level of the room. Large light gray rectangle: student bench located in the second level of the room. Dark gray rectangles: student bench located in the third and highest level of the room, White circles: seats.

Fig. 1.1. Diagram of the floor plan of Mr. J's classroom, showing the four locations (numbered light gray areas) where he stood during the lesson on respiratory system.

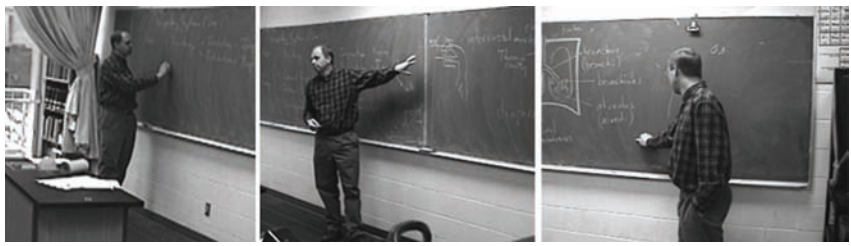


Fig. 1.2. Teacher's body position at Location 1, the area in front of the chalkboard.

For each of the locations, the associated pedagogical, interactive and discursive practices were identified. We also included the frequency of teacher gestures performed in each location and his body orientation in each instance. Synchronizing Mr. J's movements with the occurrence of speech and gesture allowed us to understand his actions as part of the larger phenomenon of lecturing, analyzing what events lead to the movement between locations, and what events follow as a result of this movement. This provides us with insights concerning the very nature of classroom teaching as a multimodal, interactive phenomenon, and particularly, concerning the role of teacher's body position in organizing and structuring the lectures. That is, we show how the body itself and through its position marks and re-marks sense.

MR. J'S BODY POSITIONING IN FOUR DIFFERENT LOCATIONS IN THE ROOM

Each location in Fig. 1.1 represents a physical space where Mr. J physically (bodily) stands at a certain moment. However, each location also represents a teaching space, which is structured and structures the activity of lecturing. During the lesson on respiratory system, Mr. J remains in each location for different amounts of time, which are recorded in Table 1.1.

Location 1 is where Mr. J spends most of the time during this lesson. This location is equivalent to the area in front of the chalkboard, which extends from one side of the room to the other. The teacher remains in this location 70% of the total time of the lesson, where he makes extensive use of the chalkboard (see, for example, Fig. 1.2). In fact, the chalkboard is the material resource that delimits this location, also providing the constraints and affordances that determine the pedagogical and interactive practices associated with this location. Thus, pedagogical practices in Location 1 are related to the chalkboard, with actions either performed on the board or towards the board. Location 1 is also the physical space where most of the gestures occur (over 97% of all gestures performed during the lesson), which is directly related to the fact that most of the lecturing also happens in this location, as discussed below.

As seen in Table 1.1, the second most frequent location in the room where Mr. J positioned himself during the lesson on respiratory system is Location 4, which is equivalent to the area in front of the first-level student bench. In this location, Mr. J

Fig. 1.3. Teacher's body position in Location 4, near the first-level student bench.

spent a little over 10% of the total time of the lesson, and his proximity to the students (see, for example, Fig. 1.3) affords a new physical configuration that is reflected in the type of pedagogical and interactive practices associated with this location. However, this physical configuration also constrains the lecturing possibilities available to the teacher. That is, the physical arrangement of the room, as much as the teacher's body positioning and the resources he uses to lecture either facilitate or make it more difficult for him to employ certain pedagogical or interactive practices, as we discuss later.

During the lesson on respiratory system, Mr. J spends less than a minute in Locations 2 and 3. Location 2 represents the area around the table in the front of the room (see Fig. 1.4), where the teacher kept his notes. Although the teacher spends only a few seconds here, this location is associated with very specific pedagogical practices that help structure the lesson, as we see in the next section. Location 3 represents the area in the rightmost corner of the classroom, near the chalkboard and beside the third-level student bench. Always arriving from location 1, the teacher usually leaned against the side of the student bench in Location 3, either placing his right hand on it or resting his right elbow on it (see Fig. 1.5)

PEDAGOGICAL, INTERACTIVE, AND DISCURSIVE PRACTICES

Most of the pedagogical practices Mr. J employed during the lesson on respiratory system are related to the use of the chalkboard. This is not surprising given that most of the lesson unfolded in front of the chalkboard, in Location 1. Thus, the teacher interacts with the chalkboard when performing common practices such as erasing the board or writing or drawing content on it. However, these tasks are performed in association with differing discursive practices. For instance, when writing or drawing on the board is the primary pedagogical practice, the teacher does so always in silence and with his back turned to students, much like while he is erasing the board. The teacher engages in these practices at the beginning of the lesson and repeatedly during the lesson, but always in preparation for a new segment of the lesson. The interaction with students in these situations is minimal, as the teacher is silent and even his body orientation (turned towards the board) may not be experienced as conducive to direct contact with students. At these moments, students tend to write down content already available on the board. Only in rare instances do the students in our videotapes ask questions, but only to clarify particular words written on the board, which the teacher promptly does.

Table 1.1. Total time spent in each location and the associated pedagogical, interactive, and discursive practices, including number of gestures performed and body orientation

Location and time spent in it	***Number of gestures performed***	***Pedagogical practice***	***Body orientation***	***Interactive practice***	***Discursive practice***
1 53min25sec	471	Erasing board	Towards board	-	-
		Drawing/ writing on board	Towards board	-	-
		Writing on board & reading out loud	Towards board/ sideways	Verbal: Q&A	Lesson content
		Drawing/writing on board &lecturing	Towards students/ sideways	Verbal: Q&A	Lesson content
		Lecturing	Towards students	Verbal unilateral/Non verbal	Lesson content
2 26sec	zero	Consulting notes	Towards notes	-	-
3 44sec	3	Waiting for students to copy	Sideways	Verbal: Q&A	Lesson content
		Talking	Towards students	Verbal unilateral/ Nonverbal	Other
4 6min54sec	11	Discussing projects/ assignments	Towards students	Verbal: Q&A	Lesson content
		Supervising students' work	Towards students	Verbal: Q&A student initiated	Lesson content

At other moments in the lesson, and also in close connection and proximity to the chalkboard, the teacher writes on the board simultaneously reading aloud what he is writing, still keeping his back turned to students. As indicated by the teacher's body orientation, the primary task is the writing, and the reading is slow, perfectly synchronized with what he is writing. The teacher engages in this pedagogical practice when writing long sentences on the board or when writing terms that are difficult to spell and/or to pronounce. This practice is usually preceded and followed by lecturing, and interaction is limited to question-and-answer sessions initiated by the teacher (i.e., the teacher asks the questions; the students are invited to answer, individually or as a group).

Alternatively, the teacher may be found to write or draw on the board as a secondary activity, adding only a single word or object at a time on the board, while always requesting the help of students through question-and-answer sessions. The pedagogical practice then is primarily related to the accumulation of

Fig. 1.4. The teacher's body position in Location 2, by the table in the front of the room.

information on the board, but it is intrinsically related and in fact depends on the participation of the students. Even though the interaction between students and teacher is mostly verbal, it is during these instances that students are more actively invited to contribute to the public performance of the lesson. The teacher may orient himself sideways between the chalkboard and the students, thus physically providing a link between his words and the content in the process of being elaborated on the chalkboard. Students' participation becomes important here, as the teacher awaits their contributions before adding anything to the board.

The opposite dynamics between lecturing and using the chalkboard also happens during this lesson. The teacher lectures about the topic represented in a diagram, equation or sentence; and he occasionally draws, labels or writes something else on the board, completing the diagram, equation, or sentence as he speaks. Students are invited only on occasion to answer questions, and interaction between teacher and students is therefore mostly nonverbal (i.e., body orientation towards each other, eye contact, head nods, and facial expression). In these instances students mostly take notes from what the teacher is talking and from the content displayed on the board. They only sporadically ask questions. These also constitute the instances when the teacher gestures most, with many deictic (i.e., pointing) gestures used to refer to content displayed on the board.

In our videotapes, we also find episodes where the teacher lectures without any direct use of the chalkboard. This pedagogical practice is the most similar to a monologue, when only the teacher speaks and the students, as audience, remain silent, and so it is also the format of communication most frequently associated to the activity of lecturing. However, while lecturing, the teacher constantly uses gestures, mostly iconic but also including deictic ones. Lecturing occurs almost exclusively in Location 1, in front of the chalkboard, with the teacher oriented towards the students. Interaction between teacher and students, therefore, is limited to the more traditional roles of teacher as speaker and students as listeners. Nevertheless, these roles include abundant nonverbal interaction, as the students as listeners participate in the communicative encounter by maintaining or shifting eye contact, expressing various reactions to the teacher's words through facial expression and head nods, and actively noting down what the teacher is saying. In the verbal dimension, the interactional pattern is unidirectional, as the teacher monopolizes

Fig. 1.5. Teacher's body position in Location 3, beside the right extremity of the third-level student bench.

the talk, with rare interruptions on the part of the students. This practice, however, is always interspersed with more interactive pedagogical practices, which require higher levels of student verbal participation.

When the amount of information available on the chalkboard was large and the students required some time to copy everything before the teacher proceeded with the lesson, the teacher would pause and wait for students to copy. This pedagogical practice always happened in Location 3 and, in our videotapes, never lasted longer than a few seconds. When the students are copying information from the board, the teacher may also erase another area of the board and start silently writing or drawing on it.

It is common for Mr. J to supervise students' work, which he always does from Location 4, where he stands closer to the students and intermittently poses or answers questions about the work that the students are doing at the time. This work frequently involves completing exercise sheets or reading from the textbook, and the teacher often gestures in the direction of these textual materials when talking to students about these. Moreover, teacher and students manipulate these textual materials together, as when, for example, they flip back and forth pages of the textbook as if searching for a particular illustration. These instances are highly interactive, even if the interaction between teacher and student occurs at an individual level, rather than at the whole-group level. The teacher interacts more often with students seated in the first-level bench, but he also talks and at times moves towards the other two benches, to talk and supervise students' work at these alternative locations. When talking to individual students, the teacher keeps the volume of conversation lower than when speaking to the whole group.

Despite the predominance of pedagogical practices that are associated with the use of the chalkboard in this lesson, there is an evident association between each of the four locations in which the teacher positions himself and different pedagogical and interactive practices he engages in. This clear association between *where* the teacher is and *what* he is doing in terms of organizing the lesson is both afforded and constrained by the human and material resources and their physical arrangement in each location. Thus, by silently standing at Location 3 as in Fig. 1.5, for example,

the teacher also communicates to students that he is waiting for them to copy information from the chalkboard. In this case, as we discuss in the following section, not only the teacher's body position in one specific location but also his movements between locations is triggered by movements in pedagogical and interactive practices, while simultaneously bringing about movement between different practices. Thus, the interrelations of physical movement and pedagogical, interactive and discursive practices constitute cause and consequence of the teacher's movements.

MOVEMENT BETWEEN LOCATIONS AS SEMIOTIC RESOURCE

Within each location where the teacher bodily positions himself in the room, particular pedagogical, interactive and discursive practices unfold, as part of the teacher's action of moving to and from or standing in these different locations. The actions performed in each location are constrained by physical aspects of the setting. Yet, within the unfolding lecture, each location is a semiotic resource that may, in the course of time, come to signify the very actions performed in this location. This repetition organizes and structures the lecture. That is, the physical layout of the room provides resources for marking and re-marking sense so that the teacher does not even have to consciously think about the unfolding lesson structure. It is given in part with the physical position that he takes. It also configures the communication, and therefore, the conceptual content of what is being articulated for the student audience.

From a social semiotic perspective, the teacher's movements around the room constitute ideological sense-making resources that are made available for students to make sense of and participate in the lecture in socially recognizable ways. This movement, however, happens as part of a larger activity (the lecture), and is associated with various other sense-making resources, such as, for example, the teacher's speech, gestures, and the diagrams and words and sentences in the chalkboard. The sense we can make of the teacher's movements, therefore, is made available and constrained by the structures emerging from the room, body position, and lesson structure. We therefore can understand the phenomenon of lectures only from a holistic, multimodal approach that considers all the resources within a semiotic unit available to and employed by the teacher simultaneously with his movement from one location to the next. In the following, we analyze the opportunities for marking and re-marking sense that arise from the locations and the movements between them. These resources exist even when not consciously attended to, much as intonation (prosody) constitutes a resource that speakers produce and use to mark and re-mark sense even though they do not consciously control it.

At time zero in the lesson used to exemplify the phenomenon, the teacher's initial position is as shown in the image to the left in Fig. 1.3. The teacher and students are reading from a sheet that outlines upcoming events and news at the school and which is given to all teachers and students at the start of the very first lesson of the day. One of the topics on the sheet relates to a forthcoming province-wide final examination, which all students must take. Here the teacher and students talk about this test.

The teacher is in Location 4, in front of the first-level student bench, a place that brings him physically closer to students. This spatial configuration not only decreases the physical distance between teacher and students, and therefore allows them to hear each other more easily, but also it represents a different social configuration, with repercussions for the way in which interaction is structured. The apparent uneventful move, from the traditional positioning of the teacher near the chalkboard to this location closer to students and away from the chalkboard, displaces the center of attention from the teacher solely to the teacher and students as a group. Consequently, interactions with students at this location are informal and unstructured, that is, students may talk all at once, and parallel conversations may occur while a student is talking to the teacher, particularly at this early stage of the lesson, before the actual lesson start. These are precisely the same type of changes that we can also observe during student-led whole class discussions, where proximity between presenters and audiences changes the discourse into a more informal one (Roth et al. 1999). In the present instance, not all students have arrived in the classroom yet, and part of the purpose of reading the day's school information sheet is to allow students to arrive and settle down before the teacher starts the lesson proper.

The interactive practices that take place when the teacher occupies this location constitute an affordance of the spatial configuration of teacher and students. At the same time, this spatial configuration also constrains the possible pedagogical practices when the teacher is placed in this location. For instance, the teacher's distance from the chalkboard renders it impossible to engage in various pedagogical practices that make direct use of the chalkboard, which limits the number and types of gestures performed in this location and the resources available for teaching scientific concepts. Even if the teacher were to gesture with reference to some chalkboard inscription, this reference would be indeterminate as the audience would not in all likelihood be able to determine the precise object that the gesture is intended to refer to. While in front of the chalkboard, the teacher can write, draw, or gesture on or towards it and use what he has written or drawn on the chalkboard in various different ways. However, standing in front of the bench in Location 4, the teacher is limited to speaking and gesturing. These limitations imposed by the spatial configuration in Location 4 account for the relative scarcity of gestures performed here and the relative little time spent at this location. However, just by standing in this location, the teacher communicates that a different social configuration is in place and that alternative interactive practices and students' ways of participating in the lesson are enabled and called for.

In this lesson, the first time the teacher moves from one location to another occurs within the fourth minute. The teacher starts to move away from Location 4 while uttering the sentence 'Provincial exams are set by the government we just sort of uh put the rest of the test into that framework' in response to a student's question. Synchronously with the utterance of 'put the rest of the test into that framework' the teacher withdraws from the bench where he is leaning on (Fig. 1.6a–b) and moves his left leg backward, turning his head and torso to the left (Fig. 1.6c) in preparation of walking to the door. The teacher's movement from Location 4 to the door is triggered by the need to open the door for a student who arrives late.

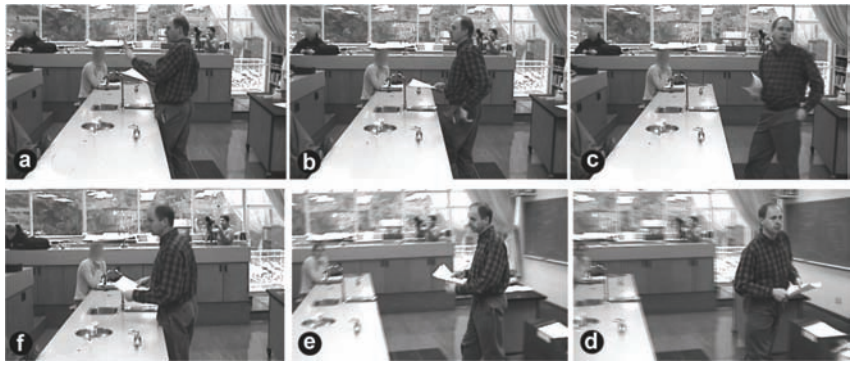


Fig. 1.6. Clockwise from top left: Teacher's movement from location 4 (a–d) to the door and back to location 4 (e–f).

The teacher is careful to finish the sentence he is uttering in response to students' questions before completely turning his back to students and walking towards the door. Thus, both finishing the verbal utterance and turning his back to students constitute aspects of the moving from one location to another that contribute to the signaling of the movement between interactive and pedagogical practices that accompany the physical movement between locations.

Figures 1.6e–f presents the teacher coming back to Location 4. Although the teacher returns to Location 4, the previous conversation is not restored. Clearly, the movement from one location to another, irrespective of the reason for this movement, is associated with a movement from one pedagogical practice to another and also from one interactive practice to another. The teacher only remains in Location 4 for a few more seconds, while he hands text material to the student that arrived late, and then moves on to Location 1, where he starts erasing the board, a social structured pedagogical practice that is associated with the beginning of a lesson. Meanwhile, students chat with each other and occupy themselves with papers, pens, and other school materials. We learn from this episode that there is a strong relationship between the type of pedagogical and interactive practices and the particular location the lecture occupies. These locations are both enabling and constraining. But we know from experience that we frequently do not consciously choose locations in teaching. What actually happens is that we take up positions with respect to the conceptual world, and this taking of positions is reflected in and mediated by the physical positions that are available to us. In this way, our entire body becomes expression, as it not only produces sound-words and gestures that normally are imbued with sense, but also produces context in its relative placement with respect to devices (chalkboard), and audiences.

Erasing the board at the beginning of the lesson is an already conventionalized preparation phase for the actual lesson start. The students respond to this action in appropriate (expected, anticipated) ways, which are also conventionalized (that is, students may take out their notebooks, write the date on the top of the page, seat

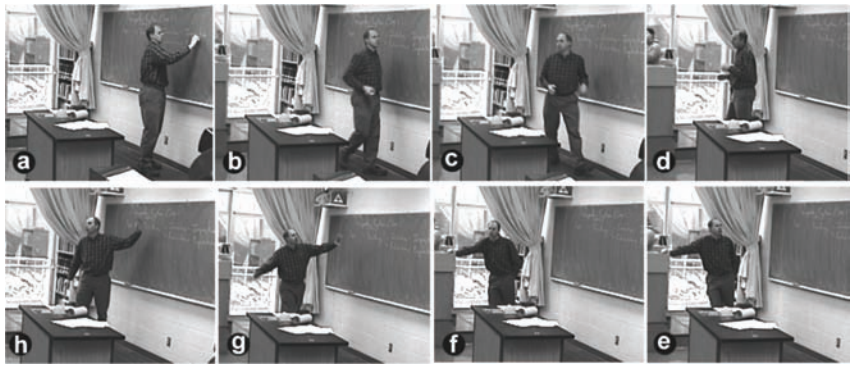


Fig. 1.7. Clockwise from top left: Teacher's move from Location 1 to Location 3 (a–d), where he looks back and forth between the chalkboard and the students repeated times (e–f), and his movement back to Location 1 (f–h).

straighter in preparation for taking notes, etc.). However, students do not stop chatting until the teacher starts talking again after erasing the chalkboard and writing on it the title of the day's lesson. As the teacher starts formal teaching about respiratory system, the students gradually quiet down. There is still a considerable amount of noise in the classroom from students' setting up their workspaces (opening and flipping pages on their notebooks, taking pens and pencils out of their backpacks, etc.). At this early moment in the lesson, the teacher talks slowly, pausing constantly between uttering consecutive sentences. He writes a couple sentences in the board, in silence, and then moves to Location 3 (see Fig. 1.7), where he briefly comments on what he has just written on the board.

While in Location 3, the teacher repeatedly orients his gaze back and forth between the chalkboard (Fig. 1.7e) and the students (Fig. 1.7f). This head and gaze movements literally makes a connection between what the teacher has written on the board and his audience (i.e., the students), to whom his speech is directed. At the same time, the teacher is able to follow students' movements and pace the lesson accordingly, waiting for students to get ready to fully and exclusively focus their attention on him before he starts lecturing. Location 3 affords the teacher an ideal positioning for both reading content from the board and seeing all the students in the room without blocking the students' view of the chalkboard. Thus, the teacher usually stands in this location while waiting for students to finish copying content from the chalkboard.

The teacher moves back to Location 1 with a sudden gesture towards the board (Figures 1.7g–h), synchronous with the utterance 'The mechanism of breathing is fairly complex', after 3.6 seconds of silence. From then on, the teacher continues lecturing in location 1.

Moving from Location 3 to Location 1 is associated with a gesture towards the chalkboard, which was performed simultaneously with a verbal reference to what was written on the board. Thus, both the teacher's speech and gesture and his

movement from one location to another referred to the information available in the chalkboard and coincided with (and indeed caused) a movement in the sequential structure of the lesson, which itself constituted an aspect of the emerging structure. That is, after this movement from Location 3 to Location 1, the lesson really starts, with the teacher speaking faster and gesturing and interacting with the board more actively, and with students quietly paying attention to the teacher and taking notes. Therefore, the teacher's action of moving from one location to another, which, in this case, also entailed the performance of a gesture synchronous with his speech, organizes the lesson and constitutes a sense-making resource that students can rely on for understanding and for appropriately participating in the lesson. The closer the teacher is to the chalkboard, the more often he interacts with it in its function as the focal artifact, and the more the teacher lectures in Location 1, the less students talk, unless invited by the teacher. In the same way that the teacher organizes scientific content in the board by writing titles, subtitles, and numbering sentences, he also structures the lesson through his action of physically moving in the space and speaking and gesturing. Each segment of the lesson becomes distinctive for the participants of the lesson by means of an ensemble of diverse semiotic resources, including speech, gestures, physical movements, body positioning, and conventionalized practices that communicate what is happening at each given moment in the lesson.

Here, the teacher's first attempt at starting the lesson in Location 1 is delayed by the students' actions (i.e., their focus of attention was divided between the teacher and setting up their workspaces). The teacher then moves away from the chalkboard and surveys students' actions, waiting for them to settle down, when he then moves back to Location 1 and starts lecturing. Here, the movement into a position is associated with a movement in pedagogical and discursive practices, and the teacher's strategic positioning at Location 3 allows him to adapt his actions (thereby structuring the lesson) to the actions of the students. In this sense, students' actions also contribute to the organization of the lesson.

The teacher moves again to Location 3, this time simultaneously with the utterance of an 'addendum' to the scientific concepts he is articulating in his speech and on the board. Standing in Location 1, the teacher says, 'And the fourth part of respiration is cellular respiration'. Then he writes 'cellular respiration' on the board in silence, and moves to Location 3. In this position, the teacher utters, 'Which is a part of grade eleven biology but strangely enough is not part of grade twelve course so' and then he moves back to Location 1, where he continues the previous sentence with 'We assume you understand a little bit about cellular respiration'. While uttering, 'assume' the teacher gestures towards the chalkboard (Fig. 1.8), pointing at the area where he wrote 'cellular respiration'.

This movement from Location 1 to Location 3 and back occurs simultaneously with a movement in the teacher's discursive practice, as he shifts from talking about the subsections of the larger unit on respiratory system to point out a fact related to the biology curricula. Although the topic of the teacher's speech still is centered on 'cellular respiration' this topic is approached from two different perspectives in Locations 1 and 3. Thus, the teacher's movement in this instance

Fig. 1.8. Teacher's gesture towards the chalkboard immediately after moving from Location 3 to Location 1.

from one location to another accompanied a movement in the way in which he dealt with the topic of his speech, that is, a movement in the teacher's discourse. As semiotic resources, these movements can be interpreted to help us understand what the teacher is saying and doing during the lesson. For instance, as students in this lesson, we would take note of the teacher's spoken words in Location 1 and what he writes on the board, but we would know not to copy down what the teacher says in Location 3. This movement from one location to another, from one form of discourse to another, from pedagogical and interactive practices is precisely what allows the audience to distinguish what is relevant and what is not within the context of a lesson. By physically moving away from the chalkboard and into Location 3, which is at the periphery of the central teaching stage delimited by the chalkboard, the teacher also removes himself from the shared focal area (i.e., the chalkboard and the scientific content written on it), allowing his discourse to be interpreted as separated from the previous and proceeding sentences uttered.

Later during this sample lesson, the teacher moves from Location 1 to 2 and then to Location 4. In Location 1, the teacher lectures with his body front turned towards the students, as shown in Fig. 1.9a. Then he stops talking, looks at the board, grabs the eraser, puts it down still looking at the board (Figs. 1.9b–d), and then moves to Location 2 (Figs. 1.9e–h). In this situation, the teacher's initial movement occurs after a pause in the lecture, which indicates a moment of hesitation that is evident in the teacher's actions (he is silent, looks at the board, grabs and drops the eraser and then turns and looks at the table in front of him, where his notes are located [Figs. 1.9a–d]). This pause already communicates an interruption in the flow of the lesson. Attuned to the teacher's actions, students can be understood as waiting for guidance, for directions about how the lesson is to proceed. In traditional lectures, the teacher's actions structure the lesson, and even without explicit instructions, students are able to understand what is happening and what is expected of them, that is, how they should act based on the teacher's actions. This may even suggest that it is not to the teacher alone that student audiences orient but to the situation as a whole, including teachers and their orientations and positions with respect to the physical setting and conceptual content. Audiences have a practical understanding of the situation as a whole rather than actively interpreting – that is, working out in consciousness – the sense of the

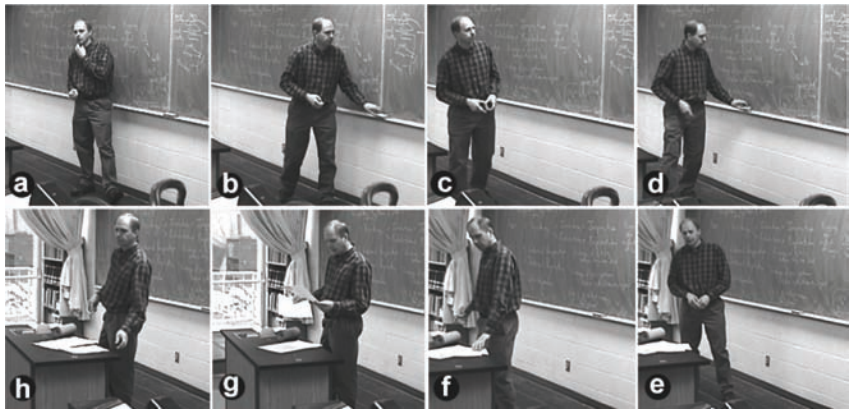


Fig. 1.9. The teacher moves from location 1 (a–d) to location 2 (e–h).

unfolding lesson. Thus, when the teacher stops talking and looks at the board, apparently unsure if he should erase something or not, students watch in expectation, try to make sense of the teacher's hesitation (in fact, seeing it as hesitation is already a possible understanding that is attributed to the teacher's actions) to act in appropriate ways.

After gazing at the table in front of him (Fig. 1.9e), the teacher utters, 'Ok so flip it over', simultaneously with his movement towards Location 2. The moment of hesitation has passed; the teacher now clarifies the nature of what is to happen next. The use of 'okay' constitutes a verbal mark for summing up one classroom segment and starting another, as does the teacher's movement between locations and his shift in focus of attention (from the chalkboard to the sheets of paper on the table). The instruction 'flip it over' is completed before the teacher grabs the sheet from the table in front of him. However, the teacher's gaze already is on the table; and, as he speaks, he moves towards the table, and then grabs the sheet, flipping it over and saying, 'At the back of the sheet I'd like you to label, from memory'. The teacher then continues this utterance with 'See if you can do that' and moves away from Location 2 in the direction of Location 4 (Fig. 1.10).

When taking his position in Location 4, the teacher supervises students' work, gazing at one of the students' worksheet and eventually gesturing toward it while talking to the student. By standing in Location 4 while students work on their worksheet, the teacher makes himself available to students: He is not busy doing anything else, he is closer to students, and the lesson now is centered on the work students are performing. The teacher's positioning and apparent inaction in this location communicates his availability. And students do take advantage of this configuration, as they begin questioning the teacher. In this situation, the teacher positioning in Location 4 not only structures a new segment in the lesson, but it also reinforces the teacher's verbal instructions to shift to another task, as he positions himself closer to students, from where he can easily supervise students' work.

Fig. 1.10. From left to right, the teacher's movement from Locations 2 to Location 4.

This supervision is, on the one hand, a reinforcement of the teacher's request (he makes sure students are indeed working on their sheets, for example) and, on the other hand, it is an offer of help, as the teacher communicates with the placement and orientation of his body that he is available to any student requiring his assistance. Thus, once again, the teacher's movement from one location to another within the classroom provides resources for students to make sense and understand what is happening in the lesson and what their actions should be. In this sense, the teacher's movement structures the lesson and the students' actions, thereby organizing interaction in the classroom.

BODY AND SPACE

The dominant epistemologies – cognitivism and constructivism – conceive of knowing in terms of thoughts and structures in the head. Communication then is equivalent to making available the content and structures of the mind to others in an attempt to establish intersubjectivity. A phenomenological perspective is different in the sense that it conceives of the entire body as expression. It has different means to mark and re-mark the sense of the current conversational topic. But the body not only is an expressive means but also produces context by placing itself relative to other aspects of the setting. The text (content of the communication) and context are produced simultaneously and constitute each other: text and *con*text constitute intertextual relations that make it possible to remark sense that would otherwise remain under-determined and indeterminate. In the present episodes, we see how the teacher's physical movement from one location to another is equivalent to a discursive movement and also to an abstract movement from one pedagogical or interactive practice to another. Thus, the same interrelation existent between the physical and the pedagogical, discursive, and interactive spaces during the entire lesson exists in the movements the teacher performs: Each movement between locations occurs in the physical, pedagogical, discursive, and interactive spaces simultaneously. The difference between these practices and spaces becomes undecidable. The medium is message and context, is as much text as the text itself. In these movements, a variety of semiotic resources are integrated to communicate sense associated with the organization of the lesson as an interactive, socially constructed and structured event. At the same time, these movements also constitute teaching strategies, as they provide new sense-making resources for understanding the concepts the teacher is teaching.

Analyzing the teacher's movements during a lesson, we are able to understand the nature of science lectures beyond the analysis of the content of the lesson and the identification of teaching strategies employed by the teacher. It also requires the microanalysis of the multiple resources used in lecturing and its association and integration, as well as an analysis of the occurrence of these multimodalities and how they are socially, culturally, and historically associated with teaching as a social activity, which is evident from a macro-perspective. Thus, different levels of analysis are required to unveil the intricacies of classroom teaching, even when we consider traditional lectures, where most interaction is verbal.

It turns out that teacher placement, movement on the classroom stage, and orientations with respect to the different spaces tend to be different for new versus experienced teachers (Roth et al. 2004). When new teachers work together with experienced teachers, they tend to 'pick up' patterns of utilizing the physical and the pedagogical, discursive, and interactive spaces. This learning process, however, is not conscious but is a direct result of the fact that the physical spaces cannot be taken simultaneously by different individuals. Thus, when two or more teachers teach simultaneously, their movements tend to be reciprocal – when one teacher relinquishes the space delimited by Location 1 in front of the chalkboard, the other teacher may move in. When the teacher currently standing 'in the wings', for example, Location 3, move toward the center, the co-teacher currently at the helm of the lesson tends to move out to make space for the teaching partner to take over or to make a contribution.

During lectures, interaction participants (e.g., teacher and students) negotiate their actions and re-actions or inter-actions by orienting themselves to the shared object of the ongoing event. Alignment between participants promotes the 'smooth realization' of the event in progress, whereas misalignments cause disruptions that need to be immediately dealt with if the event is to continue. Thus, when the teacher signals that a lesson is to start and is confronted with the students' lack of attentiveness – e.g., as they are still organizing their workspaces – he may re-orient his actions (physically, discursively, interactively) to allow students to both perceive that the lesson is starting and prepare themselves for it. This constant negotiation of joint action within the socially structured event of the lesson is what constitutes lectures as activities and what permits teaching and learning to occur. Thus, within the multitude of resources employed in various settings of social interaction, including lecturing, physical movement such as body positioning takes on a special role when considered as action that helps structure the activity and is associated with other practices that unfold during the lesson.

From this chapter, we therefore retain that there is an interaction between conceptual content of a lecture and the positions that the lecturer takes. Positioning therefore structures the lesson conceptually; and it structures the lesson temporally, when the lecturer moves from location to location, thereby making available that a change is in progress. Positioning also changes the possibilities and constraints for social interaction so that there is an interaction between physical space and the forms interactions can and will take. We also retain that positioning does not require conscious action. Rather, when conceived as expression, the entire body is

part of taking a position that transcends the distinction between the physical and the mental. The body is but a part of the situation as a whole, in which the various semiotic means produced – sound-words, gestures, prosody, orientation, position – all work together to mark and re-mark sense so that the audience may remark it as well.

CHAPTER 2

THE DELIMITATION OF NARRATIVE SPACES

In everyday conversation, we often make reference to places, objects, other people, and time. We also refer to ourselves and to the direct interlocutor(s) during the conversation. Besides verbal reference (achieved through using pronouns such as 'I' and 'you') and demonstrative terms (such as 'this' and 'there'), one can also use gestures to refer or point to something. In fact, gestures may contribute to disambiguate crucial aspects that help us to understand what the person is trying to communicate. Another way through which reference can be made is in the form of a demonstration, when a person speaking performs and therefore 'quotes' someone else's actions, gestures, or speech. In these situations, a person may gesture with his or her own body when actually referring to someone else's actions. Direct quotations are examples of these instances; the differentiation between the narrator of a story and the character the narrator quotes is possible due to markers (or 'brackets' [Goffman 1974]) that allow us to understand the quotation as such. Similarly, during demonstrations in the classroom, a teacher's bodily and verbal actions constitute markers for identifying diverse referents. That is, various verbal and nonverbal resources that a teacher makes available for the audience may be used to make sense of what is being said and done, delimiting different narrative spaces. For example, consider Episode 2.1, which was extracted from our database, in Mr. J's science class. The excerpt is part of a lesson on human physiology, in which Mr. J links events happening in the brain (pituitary), ovaries, and uterus. As the utterance 'in the brain with pituitary' (line 02 in Episode 2.1) unfolds, the audience can observe a two-handed gesture to the temples (Figure A in Episode 2.1). The teacher moves on to talk about the ovaries, whereby the utterance 'in the ovaries' occurs simultaneously with a two-handed gesture to the approximate location of the ovaries in a typical female body (line 03, Figure B). Similarly, the utterance 'in the uterus' (line 04) is accompanied by a deictic gesture to the region of the body where there typically is a uterus in a woman's body (line 04, Figure C).

Here, in using pointing gestures, the teacher is providing a frame of reference for the approximate location of the brain (line 02), the ovaries (line 03), and the uterus (line 04) in the human body. Because these are internal organs, they obviously cannot be pointed at from the outside of our bodies. Thus, any pointing gesture would only refer to the approximate location of such organs, from an 'outside of the body' perspective. However, whereas every human being has a brain, only women have ovaries and uteri. The interesting aspect of this episode, therefore, lies in the fact that a male teacher points to his body while talking about ovaries and uterus, pointing to locations where they might be located in a female body but

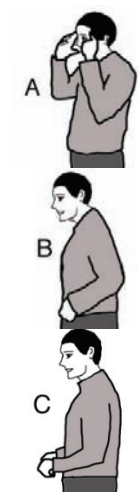
which are definitely not present in his own body. Here, as self-reference (pointing to himself) is conflated with reference (the referent of the deictic gesture is not 'inside the teacher's [male] body' but in the lower abdominal area pointed to, in a female body), a contradiction is created: the speaker points to a particular male body but treats it as a (generalized) female body. We may now ask, 'What are the semiotic resources made available that allow the audience to make sense of the lecture despite the apparent contradictory message articulated at that moment?'

Episode 2.1

```
Mr.J  01  Because there=s (0.95) events happening
          (0.35)
      02  [in the brain with pituitary      ]A
          (0.30)
          [((two-handed gesture to temples))]A

      03  [in the ovaries        ]B
          [((two-handed gesture to approximate
          location of the ovary))]B

      04  [in the uterus]C
          [((points to approximate location of
          uterus))      ]C
      05  one asks (0.57) where did it start?
```



Our videotapes show that when Mr. J in the episode above is pointing to himself while talking about the ovaries, the students in the class do not laugh. In fact, upon reflection there is nothing funny or awkward in everyday conversation about a male teacher pointing to himself while talking about the ovaries. We understand that he is pointing to the approximate location of the ovaries in a female human body rather than to 'his' ovaries. The interesting aspect is that we are able to disambiguate the teacher and his male body from the body that constitutes the referent of his pointing gestures. That is, the teacher is and simultaneously is not pointing to his own body, and the body that is pointing is and at the same time is not the body being pointed to. This potentially confusing situation is in fact unproblematically understood in real time as a case of demonstration; that is, the teacher is demonstrating the approximate position of feminine organs using his own (masculine) body as a site for this demonstration. Conventionalization allows us to interpret this situation unproblematically. Our experience interacting and communicating with other people in society provides us with the resources we need to disambiguate referents in this situation. However, what are these resources? How do they interact and are made available during the production of the demonstration so as to become clues or markers for disambiguation and unproblematic interpretation? What is the

teacher doing? What resources is he making available to us, which enable us to interpret this situation as a demonstration? The teacher does not cease to exist as a teacher. That is, it is still the teacher who talks and points. His words and his pointing hands are perceived as the teacher's words and hands, but the parts of his body to which he is pointing are interpreted as someone else's body parts. How does the audience distinguish between what is the teacher, and what is not? What are the clues we have to disambiguate 'the teacher' and 'the teacher's body' from 'not the teacher' and 'not the teacher's body'?

ACHIEVING REFERENCE

The role of disambiguating reference and self-reference during demonstrations is not only relevant for understanding lectures in particular and communication more generally, but it also encompasses the debate about the importance of contextual features into the analysis of communication. Among the many ways of achieving reference, pointing is certainly the most prominent, not only in every day communicative interactions, but also in cross-cultural communication and at every stage of our lives, as we learn and develop social and communicative skills. Deixis (a term deriving from the ancient Greek word *deixis*, reference), including deictic (pointing) gestures and deictic terms ('this', 'that', 'there'), is an essential aspect of the production of context in face-to-face communication and of the organization of perception and orientation during social interaction. However, indexicality can also be achieved through semiotic resources other than deictic gestures and words. Iconic gestures (i.e., gestures that resemble the shape of their referents) and body and gaze orientation may also work as indices. Similarly, demonstrations are considered indices for someone or something else; they constitute a type of technical redoing, one of the 'frames' in Goffman's (1974) typology. These correspond to 'strips of what could have been ordinary activity [that] can be performed, out of their usual context, for utilitarian purposes openly different from those of the original performance' (ibid, 59). Thus, demonstrations achieve reference in a different narrative space, the demonstration site, which is created for and with the demonstration. The question then is, 'How do we know that someone is performing a demonstration?' 'What are the markers that help us differentiate narrative spaces?'

DISAMBIGUATING REFERENTS IN DEMONSTRATIONS: IDENTIFYING COMMUNICATIVE MARKERS

In this section we present an episode in which Mr. J uses a demonstration to communicate a scientific concept to the students in his biology class. Through our analysis of this episode, we identify the various semiotic resources in the communicative unit, elaborating on the dynamic interplay of these resources during communication, pointing out particularly the markers that are established as a result of this interplay. Furthermore, we also describe the dialectical relationship among these resources, which at times brings forth a particular aspect of what is being communicated (and consequently, a particular aspect of the communicative

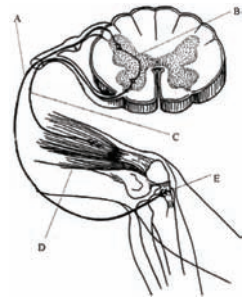


Fig. 2.1. The image projected by the teacher onto the screen.

unit) against what is then identified as background. We suggest here the existence of a communicative unit constituted by diverse semiotic resources, both verbal (linguistic) and nonverbal (imagery, material), which are simultaneously and differentially co-deployed. That is, although the ideological communicative unit may include, for example, words, gestures, material artifacts, and prosodic aspects of discourse, these different semiotic resources exist in a dialectical and dynamic relationship that enables some of these resources to come to the foreground, whereas others remain in the background. Rather than dealing with one sign that points to something else, semiotic resources point to each other and in this pointing produce each other's salience. Thus, a pointing gesture may highlight a feature of a drawing, but it is because of the significance of the feature in the drawing that the pointing gesture comes to stand out. When the mutual pointing is absent, then a body movement tends to be taken as a form of grooming, which does not contribute to referential relations that determine sense. When a teacher is lecturing, all the invariant aspects of the communicative unit become ground against which the variant aspects become salient. These variant aspects are articulated here in terms of markers, which are then used to disambiguate otherwise ambiguous communicative forms including, for example, teachers' demonstrations.

Episode 2.2 takes place during a lesson on nervous system. Mr. J has positioned himself next to the overhead projector, which rests on the table in the front of the room. Mr. J points and gestures over and about a transparency, and, occasionally, he also writes on it.

At the beginning of Episode 2.2, the teacher has projected an overhead entitled 'The Reflex Arc', containing a black-and-white, diagrammatic representation of the leg and knee, showing the muscles and joint, and a magnified cross section of the spinal cord, with nerves connecting the spinal cord with the muscles on the leg and joint (Fig. 2.1). Episode 2.2 begins with the final, unfinished utterance ('These particular proprioreceptors' [line 01]) concerning the existence of receptors connected to the cerebellum and responsible for coordinated body movements. After a brief pause, the teacher apparently changes topics in mid-sentence. He moves away from the projector and towards the opposite corner of the desk where the projector stands, while beginning a story about someone sitting in the doctor's

Episode 2.2

J: 01 These particular proprioreceptors (0.47), if you're sit-
02 ting in the doctors office (0.31), sort of dangling your
03 leg here and the doc hits with his funny little
04 rubber hammer (0.55), what does your leg do?
Ss: 05 (INAUDIBLE)

J: 06 It jumps up like that right? Is this conscious thought are
07 you thinking okay he hit me I guess I=d better lift up my
08 leg (0.82) in fact the doctor doesn't want you to use con-
09 scious thought (0.90) the doctor says just relax (0.80)
10 and he knows when you are faking it or she knows when
11 you're faking it right? So they hit you right in the right
12 spot and you sort
13 of feel it underneath that bone there give it a little
14 whap with the rubber hammer and your leg jumps (0.57), why
15 does your leg jump? Because of this built in reflex arc.

office, subjected to a test of the knee reflex arc. As part of his presentation, the teacher enacts a demonstration in which he uses his own body to illustrate what is happening in the story to someone else ('you'). Here we may question, how do students know that the teacher is now demonstrating someone else's action at a place different than the classroom where he and the students stand at the moment? In other words, what is made available to these students in particular and any of us more generally to help us disambiguate three possible situations: (a) a speaker points to his or her body as his or her body; (b) a speaker points to his or her body to stand for the specific listener's body; and (c) a speaker points to his or her body to stand for another body or a body in general.

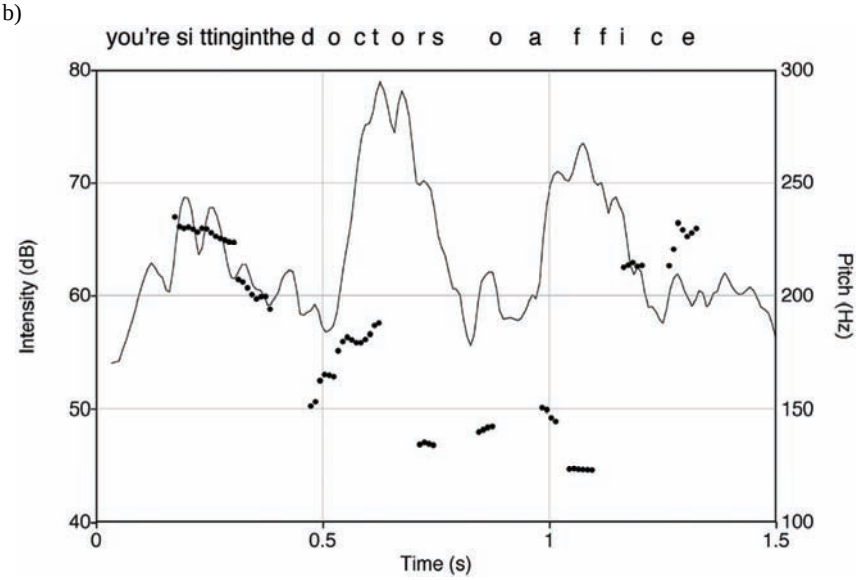
BODY POSITION DELIMITS NARRATIVE SPACES

The teacher marks the beginning of the demonstration by using both verbal and nonverbal resources that are brought to the foreground of the communicative unit in and of which they are a constitutive part. For instance, he changes his physical position as he changes narrative spaces: He has talked about receptors responsible for coordinated body movement, but then physically moves towards a different space in the room (Fig. 2.2c), while also explicitly verbally presenting a new situation. This first sentence, 'If you're sitting in the doctor's office' (lines 01–02 in Episode 2.2) is therefore coupled with the teacher's change of position in the classroom, marking the beginning of the demonstration.

Initially, the teacher distances himself (within the narrative space) from his role as teacher, by (physically) moving away from the position associated with the immediately preceding lecture position. He moves to a new position where he now demonstrates a person in the doctor's office. By moving to a different place,

a) [if you are sitting in the doctor's **<u>offi</u>**ce (0.31)]

b)



c) [((The teacher retrieves his right hand from the top of the projector and starts moving towards the opposite corner of the table.))]

Fig. 2.2. (a) Transcription of the teacher's utterance. Words underlined (for intensity) and on bold face (for pitch) represent emphasis placed on these words when the sentence was uttered. (b) Graphical representation of pitch (darker speckles) and intensity (curves) levels. An increase in one or both of these levels is identified as emphasis. (c) Verbal description of the teacher's movements while uttering this sentence, accompanied by static representations of these movements.

the teacher not only finds an appropriate setting where he can sit and enact the actions of the patient in the doctor's office, but he is also bodily marking the space (both concrete and abstract) of the demonstration, that is, framing the demonstration as a different activity from the lecture that was unfolding so far. Differentiating between these two activities or situations (patient in the doctor's office versus teacher/ students in the classroom) is crucial to the correct interpretation of the teacher's

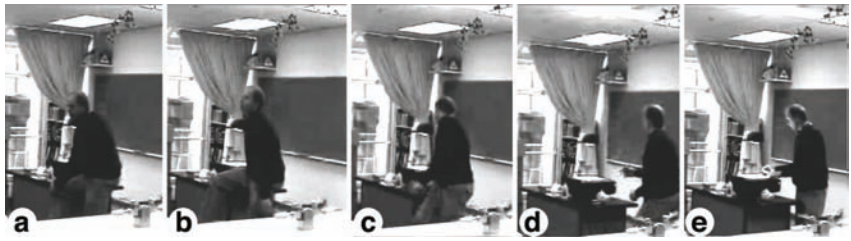


Fig. 2.3. The shift between two narrative and epistemological spaces was marked by a change in body position, which occurred simultaneously with an utterance that marked the transition from practical understanding to theoretical explanation of an aspect of the world.

actions and discourse. By changing physical positions in the room, as we work out in chapter 1, the teacher provides contextual cues (Gumperz 1982) or markers that allow us to make this differentiation between the multiple tasks that make the lesson.

Once the demonstration is finished, he stands up and returns to his earlier position at the side of the projector, resuming the talk over and about the image projected on the screen. This latter transition occurs simultaneously with a transitional utterance, 'Why does your leg jump?' (lines 14–15 in Episode 2.2), which follows a brief pause (0.58 seconds) after uttering the final sentence pertaining to the demonstration. From the position taken while producing the final utterance of the narrative in the doctor's office (Fig. 2.3a), the teacher moves into an upright position (Fig. 2.3b), standing on his feet and turns around (Fig. 2.3c), steps back (Fig. 2.3d), and then moves forward again to his original position next to the overhead projector (Fig. 2.3e). These shifts in body position and physical location in the room provide the markers or brackets that delimit the activity: 'they are neither part of the content of activity proper nor part of the world outside the activity, but rather both inside and outside' (Goffman 1974, 252). That is, the movement is part of a convention that allows us to identify the boundaries of the event and to then identify everything the teacher does and says as part of this new type of event (i.e., the demonstration), which is delimited by these movements and other markers, as we articulate below.

Here, the positions and body movement clearly mark different narrative spaces and movement between them. The physical transition occurs simultaneously with an utterance that bridges two situations. On the one hand, there is the narrative describing a visit to the doctor's office. This is a concrete situation from the everyday lifeworld that every listener is expected to have had; the narrative appeals to a practical understanding of the world. On the other hand, there is the science lecture situation, in which theories are taught and explanations are provided for the physical world generally and here the experienced world in particular. These two forms of narrative – one appealing to understanding and the other one providing explanations – are mutually constitutive and therefore dialectically related. They are very different, even negating one another, but also identical: they constitute a communicative unit.

In shifting his body and moving to different locations, therefore, the teacher marks the shift between two very different forms of consciousness: practical understanding of the world and theoretical explanations of experience. The question, 'Why does your leg jump?' which ends simultaneously with Fig. 2.3c, constitutes the textual transition point, because it appeals both to practical understanding of a leg reacting to the tap of a rubber hammer in the doctor's office and the scientific explanation of this experience. In this situation, therefore, very different textual forms and the appeal to different forms of consciousness (cognition) are associated with different positions in the classroom and shifts between them.

Similarly, in the introductory episode (Episode 2.1), the teacher, who is pointing to the chalkboard and standing sideways between the board and the students, turns towards the audience when he starts pointing to his body. This shift in position affords more than a narrative shift: By turning to students, the teacher makes his body, now used as a material resource, visible to all students. The brain, the ovaries, and the uterus are referenced by means of pointing gestures to a generalized female body, in the same way as they could be pointed at in a model or a diagram of a human torso, for example. Although this shift in body position is subtler than the one we describe in Episode 2.2, it also marks a different narrative space, insofar as the teacher shifts the focus of attention from the chalkboard to the body parts he is pointing to. Other markers, however, help us disambiguate his body from other bodies to which he is making reference.

VERBAL MARKERS OF NARRATIVE SHIFT

Simultaneously with the shifting of his position in the classroom, the teacher utters the sentence 'If you're sitting in the doctor's office' (lines 01–02 in Episode 2.2). Here, the teacher uses 'you' as the agent of the actions he performs. That is, the use of the pronoun 'you' announces that the teacher's actions at the moment should be heard as the actions of someone who is not the teacher in the classroom, but, instead, 'you', which in this particular case signifies the students as patients in the doctor's office. From a detailed analysis of various other instances in which the teacher uses the pronoun 'you' as he has done in Episode 2.2, we came to understand that 'you' means the group of students, both male and female, that constitute the audience of the teacher's lectures. The teacher excludes himself from this group, and the group seems to be characterized primarily by the students' age (e.g., the teacher explicitly talks about babies, children, and elderly people at other occasions, which are all people who belong to a different age group than the students in this class). References are also made to various professionals (e.g., school secretary, athletes), which are clearly conceived of as not pertaining to the same group as the students.

In this situation, therefore, the teacher directly appeals to students' prior experiences in a doctor's office, where they have had the kind of test that the teacher is going to talk about. In lines 02–03, the teacher elaborates on the actions the students would be performing in the doctor's office by saying, 'sort of dangling your leg here'. The use of 'here' indicates the proximity (Hanks 1992) of the

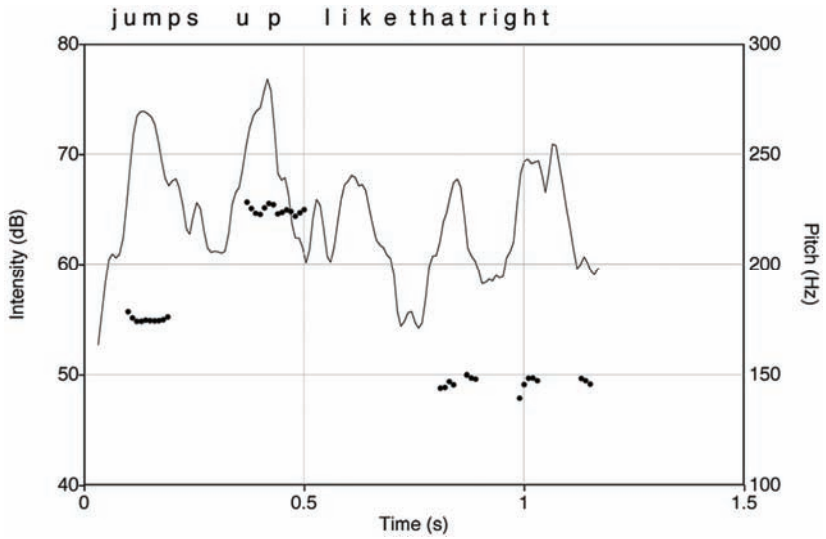
teacher (now student in the doctor's office) to the demonstration space he just has created. In this sense, the teacher is the student/patient dangling his leg in the doctor's office. The indexical term 'here' is a direct reference to the site of the demonstration. That is, the teacher creates a perceptually conspicuous site (Clark 2003), which is shared by both the teacher and the students but that is different from the actual setting where they are located at the moment (i.e., the classroom). A combination of verbal (e.g., use of 'you') and nonverbal (e.g., shifting his position in the room) resources establishes this site (i.e., the doctor's office), and now the teacher stands within this space, which makes it legitimate for him to use 'here' to refer to the demonstration site. However, the teacher can step out of the demonstration site and resume his role as teacher, without physically moving away from this site.

When the teacher asks students a direct question ('What does your leg do?' line 04 in Episode 2.2), he is in fact resuming his role as teacher by verbally stepping out of the demonstration site, within which he is still bodily present. This question is pertinent only in relation to the demonstration site. When the teacher asks the students, 'What does your leg do?' he is asking each of them what his or her leg would do if he or she were sitting in the doctor's office, dangling their leg, and the doctor were to hit their knee with a rubber hammer. That is, this question is a direct reference to the demonstration site or perceptually conspicuous site that the teacher and the students now share, and the students are expected to answer this question from within this site. The teacher neither wants students to tell him what their legs do in general, on an everyday basis, nor does he want them to describe what their legs are doing at that particular moment in the classroom. To properly interpret the teacher's question, students must rely on the context of the question, which is already presupposed because it has been previously stated in discourse (i.e., the doctor's office), and also marked by nonverbal contextual cues (i.e., moving location in the room). The question and its answer are contextualized within the demonstration space. However, the specific actions of questioning and answering to this question take place outside of the demonstration site, in the actual classroom setting. These two different settings (i.e., the doctor's office and the classroom) are marked by the simultaneous use of dialectically related resources, verbal and nonverbal, that are employed differently to mark different communicative spaces, that is, they mark narrative shifts.

After the students have answered his question, the teacher answers it himself ('It jumps up like that', line 06 in Episode 2.2), but he seeks confirmation from the students by adding, 'right?' (Fig. 2.4). Synchronously with 'it' the teacher lifts his right leg. 'Like that' in this sentence, therefore, makes reference to the movement of the leg. Moreover, the choice of words ('jumps' instead of 'kicks', for example) is coherent with the main concept being articulated, denoting the involuntary character of the knee reflex movement. Even though jumping is still an action, the leg, as inanimate entity, is imbued with action possibilities that are independent from the person's voluntary control (differently than kicking, for instance, which presupposes a conscious will from an agent other than the leg itself to perform the movement), which is an important aspect of the concept of reflex movement that

a) [It] jumps up like that right?

b)



c) [((Kicks his right leg up, with left hand touching right knee))]

Fig. 2.4. (a) Transcription of the teacher's utterance. Words underlined (for intensity) and on bold face (for pitch) represent emphasis placed on these words when the sentence was uttered. (b) Graphical representation of pitch (darker speckles) and intensity (curves) levels. The intensity level is highest on 'jumps' (74dB) and 'up' (76dB). The pitch on 'up' is also the highest, reaching 225Hz. (c) Static representation of the teacher's movement while uttering this sentence, accompanied by a verbal description of this movement.

is to be articulated. With this sentence, the teacher gets to the point of the demonstration, that is, he shifts narrative spaces again and explains particular aspects of the scientific concept (knee reflex movement). The teacher attempts to ascertain

students' understanding of this issue by asking questions and by seeking confirmation for his statements, which are actions recognizably performed in the classroom setting. At the same time, however, through the deployment of other semiotic resources such as position in the room, gestures, and previous speech, the teacher marks the existence of the demonstration site in relation to which these questions and statements make sense. The following sentences (lines 06–11 in Episode 2.2) make this intention to explain phenomena explicit, as the teacher then elaborates on the 'unconscious' (i.e., involuntary) aspect of the reflex movement. Here, demonstration space and classroom space merge, as the teacher attempts to explain a concept (i.e., involuntary nervous control of the knee reflex movement) while at the same time makes reference to the particular situation he is demonstrating (i.e., the visit to the doctor's office).

Throughout Episode 2.2, the teacher emphasizes a particular movement of the leg, within a particular context, all of which is part of the demonstration he performs. Emphasis is placed in the demonstration site and in the knee reflex movement through the use of different semiotic resources, both verbal and nonverbal, which the teacher brings to the foreground at different moments in time, relying on the dialectical relation between foreground and background, variance and invariance. In lines 14–15, the teacher asks students another direct question, 'Why does your leg jump?' This time, however, the teacher does not wait for an answer from the students, and he immediately stands up and returns to the side of the projector, where he was standing at the beginning of Episode 2.2, while already verbally providing an answer to this question. Although this question is still tied to the demonstration site, the answer to it is not.

The change in location that functioned to mark the beginning of the demonstration is now repeated in the opposite direction, marking the end of the demonstration. Concomitantly, the answer the teacher provides to this last question refers back to the projected image he has manipulated before, and helps re-establish once again the teacher as the teacher in the classroom setting. Therefore, the interplay of different semiotic resources (speech, gestures, image projected on the screen, body positioning) creates different communicative and narrative spaces (the demonstration space and the classroom space). As part of the presentation, the teacher may constitute and walk into these spaces. By walking out of these spaces, he not only terminates a narrative but also communicates to students a shift in the content of his science lesson. This also allows him to relate the demonstration he has just completed with the topic he was teaching previously and to which he now returns.

In Episode 2.1, verbal markers also help us disambiguate the teacher's body from the female body to which he is making reference. For instance, the teacher refers to 'the brain', 'the ovaries', and 'the uterus'–differently than in Episode 2.2, for example, when he refers to 'your leg'. This takes away the 'individual personhood' (Silverstein 1976, 39) attached to the organs being indexed, and makes them more general and generalizable. That is, the generalization occurs in the verbal dimension already, marking these body parts as 'stand alone' and not belonging to his body in particular.

PROSODIC MARKERS INDICATING CHANGE OF NARRATIVE SPACES

Prosody is an important interactional resource. During conversation, certain words are emphasized over others, through changes in pitch and intensity (volume) levels, and by altering the speed of speech as well. In Episode 2.2, the teacher also makes available these types of prosodic markers to delimit the demonstration space. A peak in speech intensity (Fig. 2.2b) occurs at the beginning of the words 'doctor' and 'office' (79 dB and 74 dB, respectively). (Each 3 dB constitutes a doubling of the speech intensity or, to use a theoretically more imprecise term, speech volume.) The first syllable of the word 'doctor' is uttered with a rising pitch, as is the word 'office', which rises to almost twice the normal pitch. These two additional aspects of the communicative unit also constitute semiotic resources made available during the communicative encounter. Here we may hear the peaks in speech intensity and pitch as emphasizing the corresponding sounds, themselves normally heard as words. That is, both words 'doctor' and 'office' are emphasized in this sentence.

Associated with the changing position and narrative space, there is also a dramatic shift in speech rate. Fig. 2.2b also shows that these two words are uttered much slower (1.9 words/second) than the previous words in this sentence (11.6 words/second), and about half of the average speed of the discourse during this episode (3.5 words/second). Thus, by varying the pitch, speech intensity, and speech rate coinciding with the sounds heard as 'doctor' and 'office', the teacher marks these words as salient against all the other invariant aspects of the communicative unit. Therefore, 'doctor's office' becomes the most salient part of this sentence.

In line 06 in Episode 2.2, the teacher's alterations on pitch and intensity levels place emphasis on key words that are associated with the knee reflex movement. While uttering 'It jumps up like that right?' the teacher kicks his leg up (Fig. 2.4c), demonstrating the result of the knee reflex. Moreover, the word 'jumps' is uttered with higher intensity level (74 dB) and the word 'up' presents the highest pitch in the sentence (225 Hz), with intensity of 76 dB. Here, the teacher uses prosodic resources to emphasize the particular topic of the lesson, that is, the knee reflex movement. The leg, which he describes to be 'jumping up', becomes the salient aspect to pay attention to in this part of the lecture.

Similarly, in Episode 2.1 we can identify prosodic markers that allow us to make sense of the teacher's pointing gestures. When the teacher utters 'brain' (line 02 in Episode 2.1) he does so with an increasing pitch that reaches over 230 Hz, and with a higher intensity level (82 dB). In the sequence, 'pituitary' (line 02 in Episode 2.1) is also emphasized (pitch at 210 Hz and intensity at 83 dB). Moreover, the words 'ovaries' and 'uterus' (lines 03 and 04 in Episode 2.1) are also uttered with increasing pitch (216 Hz and 240 Hz, respectively) and intensity levels (84 dB and 76 dB, respectively). Therefore, not only the teacher's gestures (pointing to the location of these organs), but also the use of 'the' and the emphasis placed on the words 'brain', 'ovaries', and 'uterus' mark these body parts as the focus of the communication, thus shifting everything else (including the teacher's own masculine body) to the background. His body in this instance is nothing more than a material resource, much like the chalkboard. However, as a material

resource used in the background of the communication, it still plays an important role in the communicative sense-making unit, and must be taken into consideration for us to interpret the teacher's message appropriately.

DIALECTICAL RELATIONS OF SEMIOTIC RESOURCES

At the same time that 'doctor's office' in Episode 2.2 is verbally emphasized through variances on pitch, intensity, and speed levels, the teacher's body positioning in the room marks the same place by nonverbal means. Although the students continue to find themselves in the same classroom, the semiotic markers ask them to follow a shift in narrative space and to imagine themselves in a different place. These are two opposing modes of cognition – verbal and imagery – that complement each other within the communicative unit, thus substantiating the 'doctor's office' within the classroom. We understand these different semiotic resources, which mark the beginning of the demonstration, as standing in a dialectical relationship. These are very different expressions marking the same overall change: the shift in narrative spaces. Thus, communication during lectures also occurs through a dialectical (and inherently dynamic) process, which includes as part of the same communicative unit a variety of verbal (e.g., words uttered, prosodic and semantic aspects of the speech), nonverbal (e.g., gestures, body positioning in the room), and material (e.g., image projected on the screen, table on which the teacher sits down) semiotic resources. To mark and re-mark sense, and, thus, to communicate something, some of these resources shift from the background to the foreground by means of variations (against everything else that is invariant, and therefore, remains in the background). These variations constitute markers that help us hear what is being communicated, the figure, against everything else that is going on, which constitutes the ground. Figure and ground mutually presuppose and constitute each other. No figure can emerge without a ground, and figure inherently means figure against ground.

Using a dialectical approach is useful, as it allows researchers to postulate movement to occur because of the contradiction that exists between concurrent expressive forms. Here, for example, the second part of the question 'Why does your leg jump?' clearly refers back to the doctor's office narrative space. The interrogative 'Why?' on the other hand, is related to a query and therefore explanation – scientific or otherwise. Concurrent with the interrogative, the teacher begins to move out of his demonstration position. That is, at this point, the intention to shift narrative spaces is already visible, though not yet achieved. The shift will have been completed when the teacher has returned to the overhead projector and returned to his teaching of scientific theory. That is, body positioning becomes a way of delimiting two different narrative spaces. Here we see that everyday practical action involves taking a position – knowing is very much an embodied phenomenon, expressed, as this episode showed, in taking positions in the world (c.f. Merleau-Ponty 1986). The change in position taking is announced in the body movement. But the resultant changes produce an inner contradiction in the communicative unit, which simultaneously is about changing position (bodily)

but remaining in the previous narrative space (‘does your leg jump?’). In the present instance, the contradiction is a force that pushes the communicative event forward. The contradiction will be removed as a matter of course in the unfolding narrative, and talk can continue only when the teacher has taken the original position again.

Similar to the establishment of communicative markers, the interplay of verbal and nonverbal semiotic resources creates different narrative spaces, allowing the teacher to move through these spaces in an unambiguous manner. That is, while one narrative space is held secure by a set of semiotic resources that at a specific instant stand for that particular space, another narrative space can be created and entered through the use of a different set of semiotic resources, all of which are part of the same communicative unit.

In everyday situations, such as biology lessons, we are always situated in a larger activity setting, we always already find ourselves embedded in a world. It is in reference to this world, a world that we inhabit, that we act and interact with others. The relevant settings include interaction participants (audiences, students and teacher), artifacts, structures, spatial organizations, and the various prosodic and other body-based resources that speakers and interaction participants make available to each other. Some of the resources available in the situation are highlighted in the communicative act – though others are taken for granted by interaction participants and therefore have to be accounted for during the analysis. In everyday situations, therefore, participants engage in a highly dynamic and dialectical process of communicating with each other, establishing and recognizing markers, and hearing and creating signification. Most importantly, all of this work is produced in an unproblematic manner. But it is important to emphasize that on an everyday basis people engage in communication of various forms, including teaching and learning at school, without being consciously aware of each and every resource they are making available to each other during this process. Unless a breakdown in communication occurs, people talk and interact straightforwardly. We do not articulate that which ‘goes without saying’ and we are able, for example, to understand a person’s actions as an instance of demonstration without necessarily taking notice of what allows us to arrive at this understanding. For instance, we may not directly relate changes in body positioning with changes in narrative spaces, although we probably use this resource to make sense of the situation. However straightforward and unproblematic, it is still crucial that researchers investigate, analyze, and ultimately theorize this process, insofar as successful communication is crucial to teaching and learning processes.