In this book, Wolff-Michael Roth takes a 38-minute conversation in one science classroom as an occasion for analyzing learning and development from a perspective by and large inspired by the works of Mikhail Bakhtin but also influenced by Lev Vygotsky and 20th century European phenomenology and American pragmatism. He throws a new and very different light on the nature and use of language in science classroom, and its transformation. In so doing, he not only exposes the weaknesses of existing theoretical frameworks, including radical and social constructivism, but also exhibits problems in his own previous thinking about knowing and learning in science classrooms. The book particularly addresses issues normally out of the light of sight of science education research, including the material bodily principle, double-voicedness, laughter, coarse language, swearing, the carnal and carnivalistic aspects of life, code-switching, and the role of vernacular in the transformation of scientific language. The author suggests that only a unit of analysis that begins with the fullness of life, singular, unique, and once-occurrent Being, allows an understanding of learning and development, emotion and motivation, that is, knowing science in its relation to the human condition writ large. In this, the book provides responses to questions that conceptual change research and other frameworks unable to answer, for example, the learning paradox, the impossibility to eradicate misconceptions, and the resistance of teachers to take a conceptual change position.
DIALÓGISM
NEW DIRECTIONS IN MATHEMATICS AND SCIENCE EDUCATION
Volume 15

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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.
Dialogism

A Bakhtinian Perspective on Science and Learning

By

Wolff-Michael Roth
University of Victoria, Canada

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Preface

In this book, I take a 38-minute conversation in one classroom—which has as its topic the production of a hierarchically organized map of science concepts—as 'excuse' for an extended reflection on language, learning, language development, linguistic transformation, and the learning paradox. Specifically, I focus on three learning paradoxes insufficiently attended to in the learning sciences generally and in science education more specifically: (a) how learners can intend to learn what they do not know and which therefore cannot serve as the object of their intentions; (b) how persons can learn something new when their current understandings and therefore their grounds and means for learning are inconsistent (contradictory) with what they are supposed to learn; and (c) how the subject matter disciplines are both reproduced and transformed over time given that today’s experts themselves have come to school yesterday un instructed about science. The answers to these paradoxes can be found in an approach to language with a dialectical materialist foundation that Mikhail Bakhtin called dialogism. By analyzing the unfolding speech during concept-mapping task in a high school physics course, I show how change in language—and therefore learning—arises without being intended from the very fact that students speak. Bakhtin postulates that any language changes that occur over millennia can be understood when every speech act is theorized as a creative act transforming the language system as a whole all the while reproducing it. This is a position consistent with that taken by the philosopher Edmund Husserl on the historical development of the sciences, or the position Martin Heidegger takes on language. In each case, the author suggests genetic mechanisms internal to the phenomenon as the reason for change. In Bakhtin, this change is the very consequence of dialogism, the non-self-identical nature of each and every word even and precisely when it is uttered two or more times in a sequence.

One of the questions one might have concerning language is the manner in which it is reproduced and, more importantly, how it is transformed and therefore produced anew. It is only when we understand how language slowly changes over time both individually and collectively that we get a real theoretical handle on language and that we come to a perspective that overcomes the simplistic view of language as a tool that people deploy to make the contents of their minds available to others. The entire book
implements this program in unfolding issues that we need to know about language. While the reader moves from chapter to chapter and within each chapter, from the beginning to its end, I introduce what is required thereby slowly building up the new perspective as a whole.

In this book, I propose taking a radically different approach than the one taken by the different forms of constructivism, all of which are based on the same Kantian metaphor of the rational Self that constructs itself, where the construction of the starting Self remains in the analytic blind spot. I propose to tackle the learning paradox in terms of a perspective on language that considers it to be a non-self-identical phenomenon. I take the Bakhtinian position—which is the one other language philosophers also take today (e.g., Derrida)—that language ("the word") is different from, and therefore stands in a dialogical relation with, itself. This non-self-identical nature immediately implies that language changes, and it does so at microgenetic, ontogenetic, and cultural-historical scales, just as the Russian psychologist Lev S. Vygotsky predicted it. I show how language is the ground, the tool, and the material (object) of and for the learner. It is precisely because of these multiplicities that we get to the emergence of new possibilities, new structural relations in what we can say about something that we cannot even envision before we actually have the language that allows us to do it. We learn language in the way we become acquainted with, and competent in, a new workplace, that is, by participating with others whose complicity we need and who need our complicity in making the place for what it is. That is, we do not learn by constructing or reconstructing our understanding. We do not learn by abandoning or eradicating what we currently know. We do not learn by receiving information, which we would not understand because our receivers (i.e., listeners, audiences) cannot be tuned in the right way prior to instruction. Rather, we learn by participating in taking up positions in the world, and language specifically—and communication generally—is but and aspect of taking up positions in ways that are intelligible by and defensible to others.

The implications for method are that we do not need to look for mental activity between the ears and underneath the skin. We find anything ‘mental’ in society and societal relations, for the structure of ‘mental’ activity is as social as that of its external objectification. Any word, because of its concrete material form, exerts an effect on social\textsuperscript{1} activity: It begins to structure internal life as much as it structures external life and gives both a more defined and stable expression. The recommended Bakhtinian implications for the study of language are as follows. We need to analyze first the forms and types of verbal interaction in relation to the concrete conditions where it is realized in concrete form. We then analyze the forms of distinct utterances, acts of single utterances in close relation with the situation of which they constitute irreducible moments, that is, the categories of speech acts. We finally examine language in its usual form. It is in the same order that language actually evolves. First, the social relations evolve. Second, communication and verbal interactions evolve in

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\textsuperscript{1} To create dialectical notions, I use the Sheffer stroke '|'. It corresponds to a logical NAND (not and) operation. If, as in the instance of agency and passivity, we have two mutually exclusive terms, that is, they are alternately true or false, the resulting statement agency|passivity—which can also be written as ‘NOT (agency AND passivity)’—is always true precisely because it embodies an inner contradiction.
the context of social relations and speech acts evolve within verbal interaction. Third, the evolution is reflected in the changes of forms of language.

Having gotten us off the ground, I elaborate in chapter 2 a foundation for my work with language. I elaborate on the problematic of the learning paradox, which, to me, is the main unacknowledged problem of much of current learning research. In the subsequent chapters 3–6, I use one concept-mapping session to introduce my way of thinking about language, learning, speaking, and thinking that I have developed in the course of reading not only Marxist scholars such as Bakhtin and Vygotsky but also in the course of reading late-20th-century philosophers, such as Paul Ricoeur, Jacques Derrida, Hélène Cixous, and others. Where necessary, I draw on other philosophers as sources for evolving a different understanding of knowing and learning and, therefore, for articulating a solution to the learning paradox that other researchers have few if any means of properly tackling.

For the purpose of introducing and discussing my argument about learning the language (dialect, idiom) of science, I draw on the transcription of one concept-mapping session that I have used for an article written and published while I was a high school teacher. To allow readers to ‘verify’ the analyses presented here, I provide the entire transcript in the Appendix. In this appendix, readers also find transcription conventions, a description of the study site, and glossary of physics terms involved in these students’ talk. During the session, the students repeatedly but briefly talked about non-science issues. I took note of the importance of these sections with respect to theorizing learning only recently. I also verified repeatedly the accuracy of the transcription and, despite the deterioration of the sound on the original VHS tape, some improvements to the transcript were made, in some instances requiring the insertion of a line (also numbered using the alphabet). That is, all inserted lines should be read as the preceding numerical line to which letters from the alphabet are added (e.g., turn 175a).

Throughout this book, I refer to ‘the teacher’ rather than using the pronoun (‘I’) and the possessive adjectives (‘me’, ‘my’, ‘mine’) to facilitate the presentation and to avoid the possible confusion between me, the author and analyst, and me, the teacher teaching the class nearly 20 years ago.

In this book, I frequently draw on foreign language versions of books and articles. I do so for the very reasons that I am writing this book, that is, for reasons of the special nature of language and the contradiction in translation, which is one of translating the untranslatable. I do so because, as a native (fluent) speaker of German and French, I can render what is said in the way I read and understand it rather than in the official translation, which often change the very sense of what is said and written. In any event, there are in many cases multiple translations of the same works that differ in essential ways. For example, I have three versions of Martin Heidegger’s Sein und Zeit (‘Being and Time’), one original and two different English translations; I also

have Georg Wilhelm Friedrich Hegel’s *Phänomenologie des Geistes* (‘Phenomenology of Spirit’, ‘Phenomenology of Mind’) in the original and in two different English translations; and I have a French and an English translation of *Marksizm i filosofii jazyka*, which in the English translation (*Marxism and the Philosophy of Language*) is attributed to ‘Valentin N. Volochinov’, but in the French translation (*Le marxisme et la philosophie du langage*) is attributed to ‘Mikhail Bakhtine’ with some editing help from ‘V. N. Volochinov’. In the French version, the translator adheres to de Sausure’s terms *signification* (signification) and *sens* (sense), on the one hand, and *theme*, on the other hand. In the English translation, a new word, *meaning* is introduced to translate sometimes sense, sometimes signification, and sometimes theme. It is not surprising that one of the foremost scholars on poetics and a commentator on Bakhtin, Tzvetan Todorov, remarks that the translations of Bakhtin’s work are often poor, contradictory, not in the least because individuals not familiar with the system of thought have accomplished them. ‘Translations do exist, but I am not sure we should derive any solace from that fact. Having practiced the craft of translator myself, I shall refrain from taking my colleagues to task for occasional lapses that, in any case, are unavoidable. However, what I find alarming in this instance is that Bakhtin has been translated by individuals who did not know or did not understand this system of thought, though I will concede that this is not an easy matter. . . . The same Russian word is not translated in the same way by the various translators, a fact that may cause the Western reader undue and uncalled-for difficulty’.\(^3\) Thus, I could ascertain that the English translation of *Marksizm i filosofii jazyka* contradicts itself within a few paragraphs. On the one hand, it states that the utterance ‘What time is it?’ has a different meaning each time it is used. On the other hand, two paragraphs later, it states that ‘meaning’ is that which is reproducible in all instances of repetition. In the French translation, sense or signification of the expression ‘What time is it?’ is the same, but its *theme* is a function of the cultural-historical situation.\(^4\)

In reading multiple translations, I have come to note that with respect to Russian translations into English, distinctions are made in the former language—as in the German language that gave birth to dialectical thinking (G.W.F. Hegel, Karl Marx, Friedrich Engels)—that are not carried over into English translations. For example, in Russian and German there are two terms denoting very different entities, both of which are translated into English as *activity*. This cannot but lead to theoretical confusion. My German colleague Reinders Duit often talked to me about how the three concepts of heat (energy), temperature, and entropy have evolved from one and the same ancient term through a process of unfolding. The separation of the intensive property *temperature* from the extensive property *heat* accorded between the 17th and 18th century, the *entropy* concept was created during the 19th century. Nowadays no science teacher or professor would accept students to confuse the three terms and the conceptual terrain these cover, though way back when one term was used to cover the

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entire terrain even scientists confused them. Similarly, to give a more accurate presentation of the thinking of a foreign-language philosopher, we need to ascertain that the translation of key theoretical terms makes the same kind of distinctions in the target language (here English) as are made in the source language. Russian and German texts in cultural-historical theories make a distinction between social and societal, but English texts use the term social to cover the terrain of both. Clearly the two terms are not identical, for if learning is societally mediated, then there is a political dimension (society as unjust, marked by inequities along gender, race, class, culture, etc.) that is not present when learning is socially mediated.

Across his works, Mikhail Bakhtin elaborates a theory of signs that he had appropriated from the Swiss linguist Ferdinand de Saussure. The French translation of Bakhtin (V. N. Vološinov) retains the Saussurean distinctions and conceptualizations (e.g., ‘sense’ and ‘signification’), whereas the English translation attempts to take different terms (e.g., ‘sense’, ‘meaning’, and ‘signification’) and thereby makes a mess of what Bakhtin was and is all about. I therefore abstain from using the term ‘meaning’ unless where I really need it, and then I place it in quotation marks. Moreover, readers of Bakhtin will note that he often engages in repetition and difference in and through his writing. I will draw on the same technique and return to the same statements repeatedly, which not merely repeat but actually augment and transform the argument I make.

Victoria, BC
March 2009
Getting Talk (and Learning) Off the Ground

How does one (cognitive) structure generate a new (cognitive) structure that is more complex than the starting one? Or to put it in educational terms, how does one aim at learning something when one cannot know what it is that one is aiming at because what is to be learned is the outcome of the instructional process? This problem, which has been named the learning paradox, challenges constructivist and constructionist approaches to learning. It is a problem that did not have a solution when Carl Bereiter first articulated its extent and it continues to be an unattended problem in much of the current learning sciences and science learning literatures. The problem exists not only for those attempting to understand learning at school but also for those who want to understand how learning at cultural-historical scales can generate more complex (rather than more extensive) ways of understanding than the currently existing ones. The history of thought has shown that dialectical and dialogical approaches have the potential to provide useful solutions because the contradictions that are expressed in paradoxes are inner features and one-sided expressions of more complex unities. Thus, Karl Marx shows in *Capital* that ‘value’, because of its inner contradiction of ‘use-value’ and ‘exchange-value’ that are enacted in every commercial act, constitutes a driver in the economic perpetuum mobile that has led to capitalism as observable in his 19th century England. Mikhail Bakhtin uses a similar approach to theorize the development of language generally and the development of literary genres more specifically. And in more recent years, Jacques Derrida, Jean-Luc Nancy, and other philosophers propose a slew of concepts on the same principle, including différence, khôra, and syncope as non-self-identical concepts/phenomena that have development as an inherent effect.

In this book, I show that the general approach to language developed by Mikhail Bakhtin with his specific concept of the dialogic nature of the word, which is the linguistic (structural) equivalent to Karl Marx’s dialectic of value, offers precisely such a

materialist dialectical framework that allows us to understand how the learning paradox is overcome in praxis. In the course of unfolding the issues of language and learning in the face of the learning paradox, I show that the ideas of Lev S. Vygotsky about the irreducible relation between the development of thinking and speaking and modern philosophical conceptions of language align with one another to produce a new perspective that overcomes some of the problems in current educational thought about how students learn (e.g., constructivism, conceptual change). In particular, the current study shows that the (radical, social) constructivist way of theorizing learning cannot help us out of the learning paradox and therefore constitutes an unhelpful way of thinking about learning or about participating in social (societal) encounters.

Getting Started

One question poses itself now: How do we get off the ground in such a chicken-and-egg situation? More specifically, if we assume that you, the reader, read this book because you want to learn something, how can I, the author, assist you given that you do not know what it is that you will know once you are done reading the book? We know that pragmatically there does not appear to be an issue, because people do learn. The question I raise here is this: How do students learn if they cannot aim at what they are supposed to learn because conceiving of and framing the aim requires them to know beforehand what they are going to learn and what they are going to know only in the future? In other words, how can learners aim at something that they can articulate only after they already know what they are supposed to learn intentionally? Or, to translate the issue once more, how can a reader learn a language (vocabulary, dialect, idiom) that is required to formulate its own purpose? (Readers should take note that I have expressed the ‘same’ question in three very different ways and that I have therefore translated an English question into another English question supposed to be the same.) To get us off the ground, I invite you into one of my physics classes, where I use a particular technique, concept mapping, to assist students in bringing together all the main concepts that are contained in a unit or textbook chapter. (See more on the background of this study in the Appendix.)

The three 12th-grade physics students sit around a hierarchically ordered set of concepts written onto slips of paper (Fig. 1.1). They have arrived at this configuration during the preceding 32 minutes. This is their capstone task of a unit on the quantum nature of light—they have previously done a unit on the wave nature of light—and the concept words on the paper slips are those that appear in bold-face in the relevant chapter of their main textbook for the course (on desk, forefront of Fig. 1.1). Their teacher, having read a number of texts on language in science and in particular Jay Lemke’s Talking Science and Bruce Gregory’s Inventing Reality: Physics as Language, has made it a practice to finish each unit (chapter) with this form of task. This task allows students to talk about the relationship between the major concepts presented in the textbook, which they are to learn according to the official, provincial curriculum guideline. We enter the session near the end of the concept-mapping task,
GETTING OFF THE GROUND

while the students, close to the conclusion of the lesson, are in the process of transcribing the configuration of concept words onto an 11-inch-by-17-inch sheet of paper. They are also asked to link relevant pairs of concepts with pencil lines and write a linking word (a verb) such that statements can be read off the map in top down, horizontal fashion, or bottom-upward direction (the latter case requiring an arrow head). Among the paper slips there are two that are imprinted with ‘WAVES’ and ‘DIFFRACTION’, respectively. The following fragment from the transcript (see the full transcript of the entire session in the Appendix, beginning p. 294) has been extracted from near the end of the lesson. In the fragment, the three students discuss the question which word (verb) they should use to link the two concept words.

Fragment 1.1 begins with Ken’s (right in Fig. 1.1) question whether they can connect WAVES and DIFFRACTION (turn 482), two of the terms to be mapped. Ralf (center, Fig. 1.1) responds that they can connect ‘it’ ‘to all’ (turn 483). Ken then utters, ‘can alter matter waves, put “can alter”’ (turn 484).

Fragment 1.1

482 K: can we connect the waves to diffraction?
483 R: we can connect it to all.
484 K: can alter matter waves; put can alter;
485 M: diffraction can alter; affects; diffraction affects;

Fragment 1.1 looks like the transcript of a simple, everyday, mundane exchange concerning the question of how two concept words are to be linked. In fact, however, we can only say that Ken asks a question, that Ralf provides a response, and that Ken...
then proposes a connecting word and therewith a proposition because of the particular relation between these turns. There is an internal dynamic to the conversation that does not allow us to break it into individual utterances but, to understand the dynamic how utterance enchains with utterance, developing until the participants no longer pursue the topic, we have to take, as a minimum, two consecutive turns as one whole unit. This unit cannot be further divided because any part would be dependent on all other parts of the unit and on the unit as a whole. This is so because ‘an utterance is a link in the chain of speech communication, and it cannot be broken off from the preceding links that determine it both from within and from without, giving rise within it to unmediated responsive reactions and dialogic reverberations’.

Because this linkage, the turn 483 actually has a double function, it completes the turn pair (with turn 482) of which it constitutes the second part, allowing the effect of the preceding utterance to be witnessed in the setting; and it offers the beginning of another turn pair unit (with turn 484), which is completed in the subsequent turn where a concrete way of connecting the term is offered. When a speaker speaks, the link between utterances does not yet exist but it comes about because any utterance is constructed taking into account possible responsive reactions. It is precisely for the sake of these reactions that the utterance, in essence, is actually created.

There is something else that should puzzle the reader. We, as Ralf has done before us, can hear Ken ask a question, ‘Can we connect waves to diffraction?’ What is the competence that allows us to hear a sound stream as a question? Note that the question mark in the transcript indicates that the pitch is rising toward the end. The transcriber, here I, has heard the utterance as a question and transcribed this hearing using a question mark. The grammatical structure of the utterance and the use of interrogatives are other clues that allow us to hear a question. However, what matters most to this conversation and to its unfolding is not what we, the analysts, hear but what the members to the situation are hearing and how they take the utterance up in their own subsequent discursive and practical actions.

Another mundane aspect of language can be observed in Fragment 1.1 that is important to Bakhtin’s theorizing. In his second turn completion, Ralf, in saying ‘we can connect’ (turn 483), repeats part of Ken’s utterance but inverts the first two words (‘can we connect’ [turn 482]). The words appear to be the same, but functionally they are different; and this different function is in part expressed in the different intonation that comes with the second articulation, accentuation, and accent. Ralf also brings in another part of Ken’s utterance. But he does so indirectly by using what linguists have come to call a ‘deictic term’ or ‘shifter’. Thus, in saying ‘we can connect ‘it’ to all’, Ralf uses the deictic ‘it’ to bring into his utterance something Ken has said without actually repeating that something. Another instance of repetition is found within Ken’s second turn, ‘can alter’. But does repetition mean that the two instances, the first and the repeated are the same? I tend to take it with Bakhtin, who tells us that they are not: ‘as an utterance (or part of an utterance no one sentence) no one sentence, even if it has only one word, can ever be repeated: it is always a new utterance (even if it is a

Elsewhere he provides an example from the work of Dostoevsky (the same example Lev Vygotsky uses to make a point about the difference between the ‘meaning’ of the same word) where six drunken workers utter the same (‘unprintable’) swear word. Even though uttered six times in a row, it is never the same word, because it is uttered with different intonation in each case. How can it be that the same word is different even though the repetition has occurred within a couple of seconds?

The first sketch of an answer is that the function of each occurrence changes in the repetition. For example, the function of ‘can we connect’ is to make salient (significant) the absence of a link between WAVE and DIFFRACTION. Furthermore, the order of the words is heard, among speakers of mundane English, to be marking the word sequence as a question. On the other hand, the function of ‘we can connect’ is to make a statement about one or more connections that can be done. In the first instance, the presence of a connection is queried, whereas in the second it is affirmed. In its second appearance, the utterance also has the function of making a link to the previous utterance. It serves as a (perhaps redundant) sign that this utterance pertains to the previous one and that these two utterances therefore constitute a pair. An interesting aspect is the change of the structural relation: the order of the words has been changed. Such syntactic changes are among the most under-analyzed features aspects of the creative production of speech and yet are among the most central to a theory of linguistic change both at the moment-to-moment level and at historical scales of language. These changes teach us a lot, according to Bakhtin, about how language is learned and how language changes at every conceivable time scale. I take it with Bakhtin who says that ‘[o]ur practical everyday speech is full of other people’s words: with some of them we completely merge our own voice, forgetting whose they are; others, which we take as authoritative, we use to reinforce our own words; still others, finally, we populate with our own aspirations, alien or hostile to them’.

In the present situation, the three students, members to the situation, speak. In speaking, they not only speak about the concepts but also, while speaking, they bring about the task context (the lesson, the session), which itself is part of the students’ lifeworld as such. That is, students, in talking, also organize the societal situation that constitutes a context of their talk (who is talking, when), that is, to manage the task (e.g., ask questions when they are uncertain about something). There are therefore different dimensions to the talk. But this fact does not seem to astonish the students; they do not seem to take notice of this. They do what they do without taking time out and without giving any indication that they have to stop to reflect about or interpret what others are saying. Maurice Merleau-Ponty is right, therefore, when he says that the ‘linguistic and intersubjective world no longer astonishes us, we no longer distinguish it from the world itself, and we reflect within a world already talked about and talking’. That is, when people actually reflect then it is in a world that is already talked about and a talking world. We live in language; we speak out of language; and it is language that speaks through us. In this world, communication and the compre-

hension of others and their speech is possible because of the mutuality of intentions, which is available in my intentions and the speech/gestures of others as well my intentions and speech exhibited in the conduct of others. ‘The sense of a [verbal, manual] gesture thus “understood” does not lie behind it, it fuses with the structure of the world that the gesture points out and that I take up in my own account, the world spreads itself all over the gesture’. In speaking I say something, that is, returning to the etymological roots (Indo-Germanic *soqʷ, *seq¹) I point, I mark: ‘the being of language is speech as pointer’.

Above, I write (think in public) about a repetition that occurs across two turns at talk. A second form of repetition, one that occurs within an utterance, is perhaps more difficult to understand as one that involves or produces a change. But a radical implementation of Bakhtin’s program requires us to understand the two occurrences of the same word in the same utterance to be different. In the present instance, Ken utters ‘put “can alter”’ (turn 484) for a second time (turn 485), and when it is done, it occurs against its first occurrence as the ground. That is, when we hear ‘can alter’ again, it no longer has the same context and function as the first time, where it initially marks something as significant. This first instance may be glossed as ‘one way of connecting matter waves and diffraction is by using “can alter”, which then forms the statement “DIFFRACTION –can alter– MATTER WAVES” on the sheet’. But when Ken utters ‘can alter’ for a second time, we can hear it as articulating his insistence, as in the gloss ‘You don’t seem to listen, I said, “put «can alter»”’. What matters for the unfolding of the conversation is not how we, researchers, interpret the statement or how the statement can be heard, but how the participants themselves are hearing it at the actual moment that the fragment is recorded. Therefore, to understand the conversation and its inner dynamic, we need to listen to how the participants hear, and we need to theorize the conversation from the perspective of the dynamic internal to it. Here, Miles at first repeats part of the proposed link, then utters a different verb, and repeats the new verb together with the subject (‘diffraction’) of the emerging predicative statement (‘diffraction affects matter waves’).

**Fragment 1.2**

<table>
<thead>
<tr>
<th>Turn</th>
<th>Speaker</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>484</td>
<td>K</td>
<td>can alter matter waves; put can alter;</td>
</tr>
<tr>
<td>485</td>
<td>M</td>
<td>diffraction can alter; affects; diffraction affects;</td>
</tr>
<tr>
<td>486</td>
<td>R</td>
<td>can alter?</td>
</tr>
<tr>
<td>487</td>
<td>M</td>
<td>[affects.]</td>
</tr>
<tr>
<td>488</td>
<td>K</td>
<td>[affects.]</td>
</tr>
<tr>
<td>489</td>
<td>R</td>
<td>diffraction affects matter waves?</td>
</tr>
</tbody>
</table>

In this situation, we observe the emergence of a new way of saying something involving the concept names ‘diffraction’ and ‘matter waves’. Ken first utters ‘can alter’ as the connective verb. The subsequent utterance, which also constitutes the social evaluation of the previous one, first repeats the word but then substitutes another one, ‘affects’. Miles repeats the verb himself. Ralf utters ‘can alter?’ with a rising pitch, as

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if producing what we may gloss as ‘should we use “can alter”?’ First Miles then Ken utters ‘affects’, each with a decreasing pitch, indicating a statement-type utterance. We may hear the first instance as ‘let’s use “affects” instead of can alter’ and we may hear the repetition as, ‘Yes, I agree, let’s use “affects”’. Ralf confirms such a hearing by uttering the implied statement as a whole, ‘diffraction affects matter waves’. But he also questions (hearable because of the pitch raising toward the end) whether this is the way the connection should be. Miles confirms (turn 490), and Ken then elaborates further (turn 491). This is not the way in which the proposition ultimately will be noted, as can be seen in Fig. 1.2. Rather, it will be fixed in a transformed way in which the subject and predicate are exchanged, ‘Matter waves undergo diffraction’. It is another translation at the very heart of language, a self-quoting that transforms the language in and through use.

The new verb Miles proposes comes to be repeated three times in the following turns 487 to 489. But initially, Ralf utters with a rising intonation toward the end (marked in the transcript by the question mark) ‘can alter?’ Such rising intonation, even in utterances as short as this, (at least fluent) English speakers hear a question. That is, although one might have heard the repeated utterance of ‘affects’ as stating Miles’ preference for this verb, Ralf can be glossed as asking whether he should use ‘can alter’ to predicate ‘diffraction’ with the expression ‘can alter matter waves’. It might also have been heard as a preference for the first of the two verbs articulated in the preceding turn. Simultaneously, Ken and Miles utter ‘affects’. But they thereby do not merely duplicate the verb Miles has already articulated repeatedly. As the period (‘.’) in the transcription indicates, both utterances are produced with a downward intonation, as we find this in factual statements of ordinary everyday talk. We can hear the utterances both as a negation of what has been offered as solution to the open problem in question form (‘can alter?’) and as an affirmation of the alternative (‘affects’). This time, Ralf articulates the entire proposition that would result, ‘diffraction affects matter waves’, and he does so with a rising pitch allowing us to hear him utter a question glossed as ‘Shall I put down “diffraction affects matter waves”?’

When one student uses another student’s words (or that of the teacher or textbook) he does not merely replicate them (i.e., in precisely the same way). When a word is reactivated, earlier forms of sense enter the later forms, giving something new to the latter. In this way, the uttered word no longer stands on its own but it includes the existence of the first utterance as its contextual ground. This is precisely the point both Bakhtin and Vygotsky make when they retell the story Dostoevsky shares in his A Diary of a Writer entirely consisting of a single ‘unprintable’ word. In this story, it is the repetition and intonation that make all the difference; it is the ‘modulation of voice that reveals psychological context within which a word is to be understood’.11 For Bakhtin, expressive intonation is the carrier of social evaluation and value judgment.12 Because the immediate situation and its most ephemeral aspects mediate the expressive intonation, no sound (only part of which we hear as a concept word) is ever going to be the same. More so, we not only hear the word, we also hear the expressive into-

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nation and therefore the social evaluation that comes with it. It is in this way, therefore, that a word—which really refers to a communicative complex that encompasses expressive intonation, expressive gesture and body movement, body position and body orientation—can never be the same. It is in this sense that we have to understand the idea of the impossibility of ever exactly hearing the same word twice.

We note that in these fragments the speech is in telegrammatic brevity and full of ellipses. But the members to the setting apparently understand what is happening and what the others say. Moreover, they refer to, or rather mark, parts of this context that are immediately there (as the slips with the concept words) or once removed (something they or others have said in the immediate or recent past). The collective speech therefore takes a form that is characteristic of inner speech: ‘Predication is the natural form of inner speech; psychologically, it consists of predicates only’.\(^\text{13}\)

Over the minute that follows, there are more proposals without apparent agreement on one. Ralf eventually says ‘give me another word’, to which Miles responds by saying ‘we gave you about six’. The three students ultimately settle on a new verb, ‘undergo’, which Miles suggests in the recording immediately after the two fragments but

\(^\text{13}\) Vygotsky, op. cit. note 11, 243.
which is different from the ‘about six’ that they have given Ralf before. Ultimately, the students complete their concept map (Fig. 1.2) slightly past the lesson bell. This map represents a summary and an account of the way in which these students articulate the concepts of their most recent textbook chapter. It also is a summary of the work that they have completed in this lesson, or perhaps better expressed, it is a trace that this work has left on the sheet of paper. This trace bears all the marks of the process, the written and verbal sources of texts that the students have produced, reproduced, and finally settled on as their solution to the problem of linking concept names in pair-wise fashion while giving expression to their hierarchical relation.

Throughout the fragments from the videotape and transcript presented above we can hear and see the three students evidently struggle with the production of but one small part of their ultimate result. They do so with words and sentences that may sound quite naïve to some readers’ ears when they are compared to the language one can find in a high school and more so in a university textbook of physics. But naïveté does not mean lack of ability. We do know in fact that one of these students today is a science professor and another is an engineer with a Master’s degree and vice-president of an innovation company. That is, despite their struggles observable in the materials presented, they have continued to evolve their competencies to participate in contexts where science-related language is used and produced. We may ask now, how is such development possible given the tentative beginnings in talking science observable here? I suggest that this requires us to take a different view on language and its development. Thus, we already see that the language employed evolves, as the students produce new ways of relating two terms, here through the repeated substitution of common verbs. In producing the map generally and the links specifically, these students use their everyday language, their vernacular, the competence of and for which they have brought with them to school, to manage both their interaction and the task. This, then, is the tenor that I take here in unfolding a different, Bakhtinian perspective on science language and learning.

**Looking Back After Lift-Off**

My text provides a first answer to the learning paradox. As you, my reader, have progressed from the beginning of this first chapter to this point, you have been exposed to the very processes that allow us to learn and to understand how learning occurs. With your familiar language competence, you have followed my exposition. Although some of what I am writing may have been unfamiliar to you, you have already had the potential for understanding this text within the horizon of your pre-reading competencies. Furthermore, what I am presenting here and how I present it presupposes its own intelligibility, for it would not make sense for me to write something that I know is inaccessible to my readers. I am also attempting to convince you. To strengthen my voice, I draw on direct and indirect quotes of certain authors, including Bakhtin and Vygotsky. I use their words, but for my own intentions, with my own inflections; and I do so in a context very different from theirs. As I deploy these words for my inten-
tion and thereby transform them, I also ready these words to be taken up again by you and to resonate in ever-new ways with every new reader. As soon as you speak to someone else, quoting Bakhtin or me, these words become further transformed, and our pedagogical language as a whole changes. It changes even if we do not think about changing it because the change is both inevitable and occurs without a special effort. A special transformation occurs as you use your language to make my language—which really is also yours, or neither yours nor mine because it belongs to the collective and to itself—the object of your inquiry. In so doing, we get a process of enfolding, recursivity, and self-reference. It is precisely through this process of integrating self-reference that we can bootstrap into new forms of speaking and understanding. There is a history of related thought that allows us to understand how dialectical relations of self-reference lead to growth, learning, and development.

Already a little more than 200 years ago, the German philosopher Georg W.F. Hegel asked himself the question how something like consciousness could ever get off the ground and develop in the way (human) cultural history shows.\textsuperscript{14} He thinks of an ingenious process that basically takes the shape of an enfolding, producing a fold. It goes about like this. The subject of consciousness, to make itself the object of an inquiry, has to externalize, objectify itself, and thereby differentiate itself from itself. When it then engages with itself in objectified form, which appears as an ‘other than itself’, it comes to understand itself in new ways because in reflecting, the objectified self re-enters the subject, thereby objectifying an objective form of its previous self. More recently, the French philosopher Paul Ricœur has offered a similar process but uses a language that readers may find more up-to-date and less arcane. Thus, when someone interprets a text, the person has to draw on his/her practical understanding of how the world works to provide an explanation of what the text says; but any such explanation augments and develops practical understanding of the world. That is, practical understanding precedes, accompanies, and completes explanation. It is the prerequisite for anything like explanation to exist and occur. But in the process of evolving an explanation, practical understanding is augmented, develops. We can therefore comprehend this process of interpretation as an occasion in which practical understanding folds over itself and, in the course, develops itself. It is the fold that stands for the complexification of understanding.

Philosophers are not the only people concerned with how a system gets itself off the ground and keeps on moving. Writers, too, have been faced with this problem. To obtain change from the inside of his *Ulysses*, James Joyce does not operate on things. Any artistic operation Joyce conducts is done in language, with language, and on language, that is, on things and on the way they are made available through the medium of language. Joyce thereby achieves change from within the system. Thus, ‘in *Ulysses*, time is experienced as change but from within. The reader and the author move towards a possession of time from inside the flow. If there is a law of the historical process, it cannot be found outside the process itself, for the option is already deter-

mined from the individual point of view one holds within the process. This, in the literary world, is the solution that Hegel proposes for the complexification of consciousness, which has to occur from within. This is also the solution I propose for learning on the part of science students, such as the ones who figure in the fragments particularly and in the entire lesson analyzed throughout this book more generally. It is the dialectic or rather the dialogic nature of language that belongs not only to these intellectuals and their intellectual lives but also to the entire evolution of our culture.

In the course of this book, I show how this process of language folding over itself, producing and reproducing itself, integrates itself over, leading to new, and developmentally more-advanced forms of language. I show how language is the ground, the tool, and the material (object) of engagement in such tasks as concept mapping. This very relationship of language to itself is the source of the autopoeisis of language and linguistic forms. These more advanced forms of language—syntactically, semantically—we hear as indicators of learning and development.

In this book, I am concerned with communication. Because I draw only on language and other communicative signs, both in the students’ use and in my describing and theorizing, there is no need for me to get underneath students’ skullcap and between their ears for theorizing what and how they know and how they learn. Focusing in this way on communication generally and language specifically comes with many advantages, including that it is objectively given for anyone overhearing a situation. We do not have to debate what a person really thinks, or the conception a person really has, because we focus on what happens collectively; and we understand from the irreducible collective situation what a person says and how others act, act upon and react to it, and therefore what forms of hearing have been enacted. Language therefore constitutes your (my reader’s) and my common ground. We are building on this ground with materials from this ground; and this allows us to get off the ground and evolve new forms of language for talking about science language and science learning.

Communication in Setting

These first fragments and analyses presented here show how students mobilize what others have said. That is, they use direct and indirect speech (writing) and thereby, mobilize (transformed) texts that are attributed to authors other than themselves. For example, the students refer to a sentence or diagram in a textbook, they directly or indirectly report what the teacher has said, they relate—mostly by means of indirect speech—what some famous scientist has articulated, and refer to something someone else has contributed in the course of the task. The students also articulate what ‘they’ are or would be saying if they ordered the concepts in one rather than in another way. In this situation, therefore, the concept names specifically and the entire arrangement

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generally constitute other aspects of the communicative event. They are both the signifier and the context that transact to produce the theme, the significance of the said in this context. Because signification always and already exists, new words can find a place in the world, and making sense of a new word means allowing it to have, or giving it a place in, a world that already exists and is shot through with significations.

The transcribed event provides evidence that students’ language is what one might describe in vernacular as ‘choppy’. It is neither well formed grammatically nor does it have much similarity with written statements, fully formed (written) arguments, and the likes that educators and learning scientists often seek in their students’ products. However, the students here do not participate in a task that asks them to utter well formed sentences only, which in fact might have inhibited them in doing what they do. They are asked to order the concept names and arrange them hierarchically. This is the object/motive of their task. They talk over and about their task, and this talk changes in the process. Their task is to formulate simple statements of subject–verb–object type (e.g., ‘the player’ ‘kicks’ ‘the ball’), which also can be understood in the form of the subject–predicate structure (e.g., ‘the player’ ‘kicks the ball’), where the predicate includes the verb of predication and the object. Predication is at the core of both individual and collective development, because it reifies the first things (objects) we know and that we know precisely because we predicate them. Simple sentences are the first predicative statements we make and that embody observation: ‘The dog is black’, where ‘the dog’ is the object and ‘is black’ is its predicate. These simple observation sentences are the beginning, the basis of language, though a giant further step is required in the evolution of language: observation categoricals that generalize across many observations. The question of generalization also is at the heart of the problem that the students here face, namely how to order the concept words with respect to each other. In chapter 7, I squarely address this issue in the context of the question of the hierarchical relationship between two concept names, ‘quantum’ and ‘photon’.

The language that serves these students as the ground, tool, and material (object) to accomplish their talk occurs in some setting. In this triple function, language itself imposes the conditions of its own production, of its own development, and of its own refinement. There are other resources in a setting such as a classroom that interaction participants can use for marking, re-marking, and remarking sense and that therefore enable and constrain how something can be said, what is actually said, how it can be heard, and how it actually is heard. Because important aspects of communication therefore remain where they are—e.g., a drawing in a textbook on the table—to be addressed or brought into communicative acts as the need arises, these aspects do not have to be named. This allows talk to be elliptic because signification is distributed across the context as a whole and can be marked in a variety of ways other than in saying (i.e., pointing with prosody, hand, finger). As soon as someone points to such an aspect, a drawing in a book or a configuration of words on the table, others can mark or re-mark them as audience or in subsequent speech of their own. And everything done, heard, and said is understood (not reflectively, but in the form of partici-

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pative thinking that expresses the same orientations among the members in the group) to be part of the overall goal of completing the task and to produce the concept map. Thus, the students make ample use of verbal and gestural deixis. They do not talk about those things that go without saying, that is, that everyone already understands and knows others to understand.

The use of gestures, body movements, and body orientations renders communication more complex, on the one hand, but also makes it easy and less cumbersome to follow for participants. Take Fragment 1.3, which reproduces one of Ken’s utterances in Fragment 1.1. In addition to the utterance, he first places his right-hand (RH) index finger onto the paper slip on which MATTER WAVES is printed (Fig. 1.3, bottom) while saying ‘alter’, and then, as he produces what we hear as ‘matter waves’, his index moves until it reaches DIFFRACTION (Fig. 1.3, top).

**Fragment 1.3**

484 K: can [alter] [matter waves;] [put can alter;]
    [(places and rests RH index on MATTER WAVE, as in Fig. 1.2, bottom)]
    [(moves RH index from MATTER WAVES to end at DIFFRACTION, as in Fig. 1.3)]
    [(returns to MATTER WAVES)]

Here we see Ken move his index finger from one inscription to another, producing an ephemeral link. He not only gestures what we understand to be a link, currently as ephemeral as any verbal production, but he thereby instructs Ralf to draw an actual,
lasting pencil link in the corresponding space of the sheet of paper. He also instructs his peer what to write on the link to be drawn: ‘can alter’. He then utters ‘put can alter’ and, simultaneously, moves his index finger back to MATER WAVES. This fragment therefore is in fact supporting the idea of making a pencil line from one term to the other, because there is not much sense in writing a term other than a concept name onto the map without also associating it with a line.

We note some interesting grammatical relations. Ken first points to MATER WAVES and then moves his arm and hand until he touches DIFFRACTION. Grammatically this would mean that matter waves ‘can alter’ diffraction. But the utterance itself is constructed with ‘matter waves’ in the object position, that is, as part of the predicate that modifies and specifies the subject. The subject of the utterance is ‘diffraction’, which is pointed to subsequently. Clearly, however, his hand is moving upward on the sheet and to the right, which means that the order of the proposition would be, in terms of the rules for reading and constructing concept maps, from DIFFRACTION to MATER WAVES. But in the second part of the utterance, the grammatical construction of the utterance, into which the words DIFFRACTION and MATER WAVES are entered by means of a gestural pointing, does produce a grammar that is consistent with standard English to yield a proposition: DIFFRACTION ‘can alter’ MATER WAVES. That is, we can actually understand the production in turn 484 as a repetition in which the speaker self-corrects before anyone else can actually intervene.

If we just consider this one turn on its own, it would make very little sense. That is, if one were to suppose that there is ‘meaning’ inherent in the word or utterance, there is very little that we would be able to draw from the statement. And yet, there is no indication from others that this communicative act is problematic. The two others, Miles and Ralf are, as can be clearly seen and heard, oriented toward the map and are in a position to perceive the pointing and the moving gestures. The entire production is part of a larger context in which students are asked to produce an orderly map, in which the printed terms are related hierarchically and connected by means of verbs to form propositions. It is precisely in the situation as a whole that we have to look for signification, which gives a specific never repeatable aspect to the utterance. This specific aspect-in-the-setting, Bakhtin refers to as theme. The available significations, that is, the preceding expressive acts and the setting as a whole, establish a common world between and including the speaking subjects, a sensible and experienced world to which the present and novel speech refers like a gesture of the head, body, or hand. Language is merely one way of taking up position in the world in which to mark, re-mark, and remark sense. There is therefore no ‘meaning’ attached to words or behind words. Students do not construct ‘meaning’. Speakers mark, re-mark, and expand significations; and they may do so using a variety of means. Participative listeners attend to, re-mark and remark the precise sense-in-the-setting of the word. That is, words are but one way in which significations can be made salient for others and for oneself. This also means that from the Bakhtinian perspective I am taking here we cannot look at an utterance in itself but always have to look at its social evaluation. The social evaluation comes from the other. That is, we consider not only the saying (i.e., utterance) but the hearing (i.e., social evaluation available in response) that others enact as well. To understand a conversation in its uniqueness as an unfolding event, we have to
make it a *social* phenomenon sui generis. As such, it cannot be reduced to and thought to be composed of the individual utterances. That is, individual utterances are not like elements that make a compound, the conversation.

This has immediate consequences, theoretically and methodically. Theoretically it means that we cannot attribute a word merely to speakers, for speakers address others and they do so with utterances that inherently are the utterances of others as well. Speakers have to (consciously or unconsciously) presuppose that their audience already is in a position to understand. That is, the intelligibility of the utterance is *presupposed* and therefore cannot be the utterance of the speaker alone—and in practical understanding it is that of the audience as well. In practical understanding, the word therefore always bestrides the speaker and the listener. This immediately implies a double relation that any utterance entertains. On the one hand, it is the completion of a turn pair and the social evaluation of the preceding turn; on the other hand, it is the beginning of a subsequent turn pair. Each utterance therefore is like a link in a chain, and we can understand it only in its dual relation to the preceding and the subsequent links that it connects. If we were to consider an utterance in itself, there would not exist any *inherent* link and therefore no conversation as a phenomenon sui generis, just talking heads spilling text independently of one another.

Methodically, the implication is that we have to analyze *turn pairs*, which constitute our minimum unit of analysis. Inherent in the idea of the unit is that there are no elements that make it. Any structure smaller than the unit is a *moment*, which cannot ever be understood on its own but only in its constitutive relations to all other moments and to the unit as a whole. Because in some cases, the participants make salient that some misunderstanding exists, it might take several turns to complete such a unit. For example, an utterance might offer up the first part of a question-answer unit, but, because the addressee does not understand, it may take several turns before the answer completes the unit. Science educators are already familiar with other turn-taking units, including the school-specific sequences whereby a teacher initiates, one or more students respond, and the teacher evaluates (sometimes better known by its acronym IRE). This unit might actually be longer than three turns at talk and therefore might be found spread over a long series of utterances (e.g., if a student were to say, ‘What do you mean?’ or when the students do not bring forth the sought for answer in the center slot between initiation and evaluation).

I begin this chapter with the framing of the key issue: How do we get out of the learning paradox? The learning paradox articulates the contradiction that exists because persons cannot intend learning something that still lies outside the horizon of their comprehension. Just as Christopher Columbus could not *intend* to discover the Americas—had he known them, he could not have discovered them because he already knew they existed—students cannot intend learning something that they do not already know, just as poets cannot make clear what they want to say until they have developed the language in which they succeed in saying the poem and making clear what they want to say. Or, to put it into conceptual change terms, if students do not know the target cognitive structure, how can they *intentionally* engage in constructing it? How, if you do not know the target structure can you construct an analogy, given that there are so many structures in the world that serve us as a source? How can you
construct a specific structure if you do not and cannot yet have a plan or even the lan-
guage to formulate such a plan? This is especially the case when students are required
to engage in ‘radical restructuring’ of their ‘conceptions’, because what is taken to be
their current, source conceptual structure is completely incompatible with the target
conceptual structure. How can the students engage in intentionally construct a concep-
tual structure that is radically different from what they know right now and of which
they know as little as Columbus knew of the Americas?
In this book, I am concerned with the puzzle of language, learning, and the learning paradox. Concerning the latter, I provide the beginning of a solution through a dynamic perspective on language that exists in the concept and phenomenon of dialogism. In this perspective, there is no phenomenon such as the language, for what we are after is in continuous flux. We therefore need a genetic approach to the study of language and speech. At best, we can produce an idealized language by fixing it at a particular instance in time. We then can arrive at something like the language of a novel such as Ulysses, which James Joyce conceived of as a ‘total work, a Work-as-Cosmos’, where ‘the reference point is not the poet in his ivory tower but the human community and, ultimately, all history and culture’. This requires a historical-genetic study of language, because, like literature, it is impossible to study it from the historical place of a particular culture, and it is even more fatal, to paraphrase Bakhtin, to encapsulate language in its own contemporaneity. Bakhtin speaks in a similar way about the language and world of Rabelais or about the poetics of and discourse in Dostoevsky’s writings. We cannot understand the language or the genre that these authors use independent of their cultural-historical positions. But, as articulated especially in his Marxist, sociological perspective on language, Bakhtin emphasizes that language generally, and genres such as the novel particularly, do change because of a mechanism internal to language itself: Change and renewal occur every time someone utters a word, a novel or poem being only one of the forms that an utterance can take. To know the effect of an utterance, whatever its form (a word, longer verbal utterance, poem, novel, or play), we always need the social evaluation to understand its role in the evolution of its cultural-historical situation. In the case of the spoken word, this evaluation occurs in the immediate situation, whereas in the written work the evalua-

tion is produced during the reading of a piece of work and during the subsequent discussion of it in various public arenas (Internet, literary scholarship, marketplace).

Bakhtin’s work on the evolution of literary genres is useful here, because it may enlighten us about the question concerning how complex forms—literary in his case—emerge from simpler ones that precede them. In the way Bakhtin views the evolution of the novel and other speech genres to be driven by the change in everyday language, I approach the change and complexification of students’ science language as occurring in, with, and on the basis of their everyday vernacular that begins, accompanies, and completes the specific languages, genres, idioms or dialects that they learn in their subject matter classroom.

In this chapter, I articulate the background to the problematic that I address in and with this book. I begin by exhibiting some of the conventional approaches to language, before revisiting aspects of my very early work on language generally and on concept mapping in particular. I articulate and elaborate the learning paradox as an ontogenetic and as a cultural-historical phenomenon. I outline some of the context that comes with the particular perspective I take here on language, which takes Bakhtin’s work as the ground but also draws on other, sympathetic and commensurable perspectives on language, such as those taken by pragmatic philosophers (Davidson, Quine, Rorty), philosophers of difference (Derrida, Nancy), or hermeneutic and phenomenological philosophers (Merleau-Ponty, Ricoeur).

Conventional Approaches to Language

In this ever-too-brief section, I present the approach many educational researchers take in analyzing classroom conversations: Language as a means to make public private thought and thought structures or to take a stand and stance. I do not do so to set up a straw-person, which I then knock down. In fact, I am not so innocent myself. In the (now-somewhat-distant) past I have contributed, in and through my research, to the reproduction of this very view of language as a transparent window that I now undo in writing. I have used language—just as the work that I use in the following to exemplify problematic practices in the analysis of speech—as a transparent window into the minds of students, their intentions, and their knowledge and understanding. But my past understanding does not hold up in the face of the thousands of hours of transcripts that I have been analyzing. In this book, therefore, I both renounce the old position and offer a new, better and much improved one that does not lead to the logical contradictions within my earlier work. For the demonstration of how and why my new, Bakhtinian approach to language differs, I do need to provide some sample analyses to articulate the difference more concretely. I therefore take some randomly selected analyses from the literature to exemplify my point.

Language commonly is taken as a transparent window on the mind or as a medium more or less independent of the conceptual structures of the mind. This may not be surprising given that much research implements a Kantian constructivism and given the generally unarticulated fact that ‘nowhere does Kantianism offer a theory of lan-
guage, of the purity, or of the originality of language’. As an example of how transparency works in a concrete case, take the following brief exchange between a conceptual change interviewer and a 15-year-old student named Jane. The interview concerns the phenomenon of refraction (bending) when light moves from one medium, such as air (glass), into another medium, such as glass (water).

**Fragment 2.1**

**Int.** Would you like to tell me what happens here to make it [the beam of light] bend?

**Jane** Because it is going through different densities . . . it makes the light bend.

**Int.** How does the density affect the beam to make it bend?

**Jane** I’m not sure. Don’t know.

**Int.** Have you got any idea what happens here to make it bend?

**Jane** The light slows down . . .

The interview subsequently continues, where we find another exchange.

**Fragment 2.2**

**Int.** Any idea how that [bending] happens?

**Jane** It might be or it might not be different densities in there [the glass block].

Based on these two fragments, the authors make two claims to support their conceptual change approach. First, they suggest that ‘Jane demonstrated that the notion of refraction being related to light changing speed in media with different densities was intelligible to her’. They continue by suggesting that ‘statements like, “I’m not sure” and “it might or might not be” indicated that she did not necessarily believe that this is how the world actually is and the concept was probably not plausible to her’.

We can make a number of observations. First, the authors reduce a complex phenomenon of interaction to two brief statements about what Jane finds ‘intelligible’ and about what she ‘believes’. Readers can immediately ascertain, however, that Jane does not talk about intelligibility whatsoever. We see Jane and the interviewer engaged in exchanges about some topic and there is little evidence that the topic makes much sense to Jane at all. We do hear her say ‘I’m not sure. Don’t know’ when the interviewer asks her how density affects the light beam to make it bend. Jane here articulates for us that she is not sure, and she then revises this statement to ‘don’t know’. Yet the authors claim that Jane ‘demonstrated’ that ‘the notion of refraction being related to light changing speed in media with different densities was intelligible’. Jane says that she does not know what makes the light bend. The interviewer insists and Jane then offers up something, ‘light slows down’. The authors do not tell us what comes after, so we do not know the appreciation of the comment that the interviewer

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provides to Jane. We do not know, therefore, how, from a conversation-as-phenomenon-sui-generis perspective, that contribution mediates between Jane’s preceding ‘I’m not sure. Don’t know’ and what comes thereafter. It might be that the interviewer expresses appreciation that Jane has ventured something. We do not know whether Jane proffers ‘light slows down’ as a hypothesis, whether she repeats something she has heard in class; and we do not know whether she is mobilizing the expression for her own intention or whether she merely seeks to satisfy the interviewer by contributing to the conversation in such a way that the interviewer can proceed in his/her protocol.

Second, the authors do not attend to the fact that the interviewer offers up the connection between densities and changing speed in asking ‘How does the density affect the beam to make it bend?’ The syntactic construction of the sentence makes it such that something other than bending is the searched for answer. Had the interviewer asked ‘How does density affect the beam?’ a possible response is ‘It makes it bend’. Here, however, bending is already part of the query so that the question—if the utterance is heard as such—tempts to elicit something else. The interviewer subsequently asks Jane whether she has an idea about ‘how that happens’, to which Jane responds, ‘It might be or it might not be different densities in there’. Jane responds, and in responding assists the interviewer to get through his/her protocol and complete this part of a research project. There is nothing in this excerpt that allows us to say that Jane ‘believes’ or ‘knows’ anything about light refraction, density, and different speed other than that she knows the words and short phrases. Whether these sentences are partially her own is not known and it remains unknown whether she has any intentions other than doing what she does, that is, duly responding when she is asked.

Third, the authors claim that in saying ‘I’m not sure’ and ‘it might or might not be’ Jane ‘did not necessarily believe that this is how the world actually is and the concept is probably not plausible to her’. Again, the authors put words into Jane’s mouth and thoughts into her mind (see chapter 9 on putting words into someone’s mouth and subsequently believing the other has actually said something to that effect). Jane does not tell us what the authors claim that Jane believes and that she finds something plausible or not. The authors thereby treat language as a medium that allows them to get at something that characterizes Jane—her knowledge, her beliefs—without actually saying so. This something is said to be in her mind. That is, the authors presuppose something to be in Jane’s mind that makes her say what she says. And even when Jane acknowledges being uncertain and not knowing, the authors attribute to her knowledge and beliefs. What their analysis does is this: it turns Jane into a fixed entity, a person with a (at least momentarily) fixed mental structure that can be probed by asking the right questions. The authors leave out the competencies required of Jane to participate in this way and her express willingness to respond to questions and thereby to constitute the event for what it is planned, an interview. The authors rather than Jane pull together different aspects of an unfolding event and say that all of this can be attributed to Jane and her current knowledge and her set of beliefs.

In fact, there is little evidence that the authors work with the transcript by staying right at the words that people are saying. They read the transcript through their conceptual change framework independent of how Jane and the interviewer bring the ses-
sion about and independent of what Jane formulates to be her intention, beliefs, or knowledge. The analysts force the interview onto the Procrustean bed of their conceptual change ‘framework’, without noticing that they may actually stretch or shrink the language and situation in the way that the mythical Procrustes stretched and shrink his guests to make them fit his (previously adjusted) guest-bed. For example, Jane says that she does not know (the answer), and yet, the authors attribute to her knowledge. Jane herself says she does not know, whereas the conceptual change researchers attribute the (lack of) plausibility and intelligibility of an idea or concept to her.

To discourse and conversation analysts, including myself, such an approach is unacceptable. We want to understand how the interview unfolds and how the participants sustain a topic, and thereby the event as a whole, over some time; and we want to know what the interaction routines are that allow participants to do what they do. We take the conversation to be an irreducible phenomenon the results of which cannot be attributed to individuals. It is irreducible because every turn completes a unit, provides us with the social appreciation of the preceding turn, and is a first part of the succeeding turn-pair unit, which itself is completed in a subsequent turn. Was the interviewer satisfied with Jane’s utterance ‘The light slows down’? If the interviewer moves on to a different topic, this may be clearly understood as an evaluation that the previous topic has been completed. The interviewer may provide further signs of completion of an interview section by fiddling with some papers to look for the next item on the interview protocol.

Conceptual change researchers are not the only individuals taking language as a transparent window into the mind. Even researchers who reference the work of Vygotsky analyze utterances as if these provided windows on the mind of the conversation participants. To exhibit common ways of analyzing transcripts, I randomly accessed a recently published article and analysis of knowing and learning in science classrooms. In this article, even though the authors ground their work in Vygotsky, they provide analyses and make claims that ought not go without challenge because of issues that I problematize in this book. Take the following excerpt from a lesson in which the children were asked to classify, among others, toothpaste and the authors’ interpretation.

Fragment 2.3
5 Terrance: I think // I.
6 Joe: It’s solid.
7 Terrance: We think it’s um gas.
8 Joe: A solid.
9 Kimberly: Um I think it’s a liquid.

7. In my lab during data analysis meetings, we call it ‘going into someone’s head’. There is a lot of laughter, for when challenged to provide proof for the assertion about what a person really thinks or intends, the person having made such a claim cannot ever provide it. We therefore challenge each other to stick with what is actually said rather than with something inaccessible behind it.

8. The quote and subsequent interpretations are taken from Maria Varelas, Christine C. Pappas, Justine M. Kane, Amy Arsenault, Jennifer Hankes and Begonia M. Cowan, ‘Urban Primary-grade Children Think and Talk Science: Curricular and Instructional Practices that Nurture Participation and Argumentation’, Science Education, Vol. 92 (2008), 65–95. The excerpts are from pages 74, 75, and 78.
The authors use this piece of transcript to claim that there are social and cognitive relationships interwoven. More particularly, they claim that ‘Terrance first changes his mind from “I think” to “we think” signaling group agreement, but quickly Joe and Kimberly object to that’. They do not point us to any evidence that Terrance consciously revises what he has said; and we do not see evidence that he has done so because of what others have said in the meantime. Neither is there a direct relationship between words and thought nor is the relationship between the word and thought constant. This is so because ‘the structure of speech does not simply mirror the structure of thought’ because ‘the simplest utterance, far from reflecting a constant, rigid correspondence between sound and meaning, really is a process’.9 Unless a child in the situation was to say, ‘I changed my mind’ or some other child or teacher were to say, ‘he changed his mind’, we have little if any evidence that an actual change of mind has happened. And would such a ‘change of mind’ have to be modeled as a conceptual change, an opinion, or as declarative or procedural knowledge? We have to study the situated development of (cultural) thought in minute-to-minute, temporal, and historical fashion precisely because the syntactical organization and psychological organization do not tend to accord in the way generally assumed. Thus, only a cultural-historical theory can deal with this and similarly complex problem that the study of thought and speech constitutes, where the genetic method pertains not only to temporal scales of history and development (ontogenesis) but also to the moment-to-moment unfolding of thought.

The authors also claim that Joe and Terrance ‘negotiate and argue about their ideas’, as trying to ‘argue about [their] position’, contradicting themselves, changing their minds, or ‘hold[ing] on to their reasoning’. There is no evidence that they actually negotiated or intended to do so. Rather, all we can hear (see) is that students articulate different categorical descriptors for the same substance (tooth paste). Another equally-to-be-justified description of what happens in the episode would be that the children confronted one another with their opinions. Already as a high school physics teacher, while watching videotapes of my concept mapping lessons, I noted that students contributed to ‘collaborative’ sessions in the way seen above, clearly without learning in the situation. To assist them in learning from one another, I then modeled for them the practice of asking for explanations, elaborations, and justifications. I wrote large posters with these three words and actively reminded students not to put up with someone else merely making statements—as the children in the episode—but to argue each point, which requires individuals to elaborate their ideas, explicate, and justify them. The videotapes of subsequent lessons show that student learning does improve with the improvements in the interactional processes. That is, watching videos back then led me to the opposite conclusion than the one arrived at by Varelas and colleagues, students are making statements rather than arguing and engaging with ideas. The changes that occurred proved me right in the sense that students did come to learn more once they engaged in processes that I could recognize as arguing ideas.

The illustrated forms of analysis come with the danger that we allow thinking to be connected directly to words. Thinking, in this approach, first is taken to be hidden,  

secret, and private; subsequently it comes to be presented publicly in words, as if the person were ‘spilling beans’. This is consistent with Kant’s constructivist philosophy where reason can stand on its own, constructing itself from certain a priori givens. Language is needed so that others may understand us, as we understand ourselves—but this language is marked by ‘the absence of tone, the absence of the seductive, contagiously affect-laden voice, the absence of the veiled voice’.\(^{10}\) Many authors analyzing conversations in this manner do not generally attend to the unfolding evolution that occurs. They do so despite evidence in the literature that thought \textit{emerges} from very fuzzy general seeds and then develops as it realizes itself in language and gesture; and they do so despite theoretical arguments that verbal articulation \textit{mediates} and \textit{transforms} thought. Researchers going about analysis in this manner do not heed the advice that ‘[n]o matter how they were interpreted, the relations between thought and word were always considered constant, established forever. Our investigation has shown that they are, on the contrary, delicate, changeable relations between processes, which arise during the development of verbal thought’.\(^{11}\) When Kimberly comes to speak the situation no longer is the same as it was for Joe (line 6), who makes the first statement. It is an opening, and other statements do not merely occur, but they occur against the background of what has already been said. More so, Joe cannot know what others will say after him, and, in most everyday conversations, others (here Terrance and Kimberley) do not know what they will say 15 seconds, a minute, or an hour hence. Yet we know that conversations build on what has been said, and (university, funding) committees may arrive at classifications and at statements that are not even close to what anyone has come to the meeting with. In fact, committees at times come to conclusions quite opposite to what any single member has thought prior to the meeting.

At the end of \textit{Thought and Language}, Vygotsky suggests that thinking and speaking hold the key to practical consciousness, which reflects the physical and social reality of persons in action. His precisely one-year-older contemporary Mikhail Bakhtin refers to understanding practical consciousness as \textit{participative thinking}.\(^{12}\) This concept fits into the non-reductionist approach that I take here. We participate in a world without having to reflect. This does not mean that we are like robots doing what we are programmed to do without thinking. Rather, it means that there is a lot of skill mobilized in making societal situations what they are, and each of us contributes in the collaborative work that brings society off in the way that we experience it. Therefore, our understanding is not mechanical and we understand societal situations \textit{participatively}, as knowledgeable participants, rather than in a reflective way. We rarely stop and reflect in everyday life, we just jump in and engage and contribute to making the situation happen. Students such as Jane, Kimberly, Joe, or Terrence participate in a situation, which is not a box within which they find themselves but which is something that their action creates simultaneously while speaking about the topic. They ‘know’ what is happening not because they reflect or reflect upon the situation but because they have taken positions in this world and collaborate with others to make it

\(^{10}\) Nancy, op. cit. note 5, 78.
\(^{11}\) Vygotsky, op. cit. note 9, 254.
what it is: a(n) (un-) successful conceptual change interview or a(n) (un-) successful science lesson. To better understand participative-thinking-in-action and its relation to language, the analysis of situations in which speech features (conversations, lectures) therefore needs to take into account developments that occur at the microlevel—where they take this or that direction—as well as more global directions and developments (ontogenesis, culture). It is only by providing appropriate theories for the real-time, dialogical production of participative understanding, knowing, and learning that we can test them for their plausibility and fruitfulness.

Some readers may claim that the hearer of the talk (reader of the transcript) can understand what the speaker means. But this gets us precisely at the heart of the problem that hearers themselves are attuned to what the speaker means even if the speaker does not say as much. The degree to which the two forms of understanding overlap depends, as Vygotsky illustrates through an analysis of a scene from Lev N. Tolstoy's Anna Karenina, on shared culture and degree of familiarity between the interlocutors. How do we know that a speaker actually means what someone attributes him/her to mean? A talk may be characterized by stumbles, mumbles, pauses, non-grammatical production, and so on all of which are part of a non-fluent production. So what does a speaker think? How competent is s/he in the domain that s/he is to teach the students present in the classroom? The purpose of this book as a whole precisely is to develop and articulate a way of approaching talk that differs from the ways in which talk generally is analyzed, theorized, and explained in the (science education) research literature. My investigation takes a dialogical perspective on thought, which not only continuously changes but which also stands to language in an ever-changing relation. In so doing, I go beyond the giants on whose shoulders I stand in considering material forms other than language in which thought realizes itself and to which language bears a complex relation.


As articulated at the beginning of the previous section, I am not innocent and have contributed to the reproduction and transformation of linguistic analyses of school science lessons in the way I critique. Here I return to my research in which I first reported my work on concept mapping and in the context of which I recorded the videotape and produced the transcript that I use throughout this book. Prior to doing this work, I had begun my research career employing a neo-Piagetian information processing approach before moving on to constructivism. Very early on in my encounter with constructivism, I became familiar with an area of research that reported how science was really done rather than how science is described in the methods descriptions of research articles. This research area, generally referred to as the ‘social studies of science’, includes sociologists and social constructivists. I immediately found the studies and frameworks more interesting than the radical constructivist works that I had read in large part because of the trouble I found students to experience doing concept mapping on their own and the greater facility they showed when working on the task in
groups. In particular, my observations as a teacher, which appeared to be consistent with a sociological or social constructivist perspective of learning in real classrooms, led me to evaluate the social constructivist perspective more favorably than the radical constructivist position. Perhaps not surprisingly, therefore, already more than a decade and a half ago I featured the results of my teacher-researcher studies regarding concept mapping in one of the first science education articles on the ‘social construction’ of scientific concepts. The work was conducted in my high school physics classes where students completed concept-mapping tasks on a regular basis.

The article came during a turning point in the field of science education when some researchers moved away from the Piagetian stage and information processing theories in vogue just before that. The field had begun to explore, among others, radical constructivism as a suitable alternative paradigm. The role of sociocultural forces and mediating elements was new to the field. Today, however, the idea of the social construction of knowledge is probably uncontested, though precisely what it means in a context that continues to favor the focus on individual learning outcomes—e.g., testing, grades, career progress all are based on the individual as unit of analysis—remains to be shown. The question one might pose is whether individual or social construction as metaphors of learning continue to be useful in the face of other, alternative theories that have very different implications for science learning environments, curriculum design, research on science learning and instruction, and so on.

Language-based approaches have experienced an increase in popularity since Jay Lemke’s early work in this direction. However, the types of analyses he offers are highly technical and demand the deployment of functional grammars. One shortcoming of such analyses is the fact that few if any teachers of science will find functional analyses useful, especially in the here and now of the unfolding classroom. Moreover, one of the criticisms Bakhtin might have voiced about Lemke’s approach is the apparently static form of analysis that focuses on stable patterns in language and on the thematic patterns of actor-process-location-classifier relations in sentences. For Bakhtin, the most important aspect of language is its change, the continuous change of the theme; and the stability of a language is only a figment, an image that results when a whole system is frozen in time at a single instant. Instead, we need to think of language as something living, something self-changing in the very moment that it realizes itself, including its grammar and thematic patterns. The writings of Jacques Derrida and Hélène Cixous, the founder of écriture féminine, are exemplary in this context, because the movement of language is available right in the text and brought about by means of the text.


cal language philosophy articulated by Mikhail Bakhtin and members of his circle and akin ways of understanding thinking, speaking, and being in the world. One of their key concepts, dialogism, is sometimes taken up in the Western literature, but not in the way it was designed. Rather it is used to refer to situations that involve conversations, dialogues, in small groups or whole classes. But Bakhtin insists that dialogism is not the same as dialogue. The latter term refers to two or more individuals having a conversation, whereas dialogism refers to the non-self-identical nature of the word specifically and of language in general. In other words, dialogism is the idea that a word uttered as part of some conversation does not belong to the speaker, that it is not an expression of something that the individual spills from his or her mind into the public arena. Each signifying element that can be isolated within an utterance—as well as the utterance in its entirety—finds itself transferred to another context, an active context of a response. Signification therefore does not lie in the word or, for this matter, in the soul of the speaker or, to add the counterpart in the conversation, in the soul of the interlocutor. This is so because ‘signification is the effect of the interaction of speaker and recipient, imposing itself on the material of a given sound complex’.¹⁵ That is, the word, which has come to the speaker from the others, in speaking, is for the other and, in speaking, returns to the other: It bestraddles speaker and audience. In fact, one may also say that language uses speakers and audiences to reproduce itself as a social rather than as an individual phenomenon, a way of expressing the situation that is reminiscent of Martin Heidegger’s expression ‘Die Sprache spricht’ (language speaks).¹⁶

In this book, I provide an alternative reading of the concept-mapping lessons that had founded my original social construction argument. I show that we can do learning science and science learning research as concrete human psychology and objective psychology that does not require to construe mental worlds but that finds all its data and evidence in social relations and the natural worlds that are available to and used by members to a setting. That is, I do not argue that there are no private thoughts or that there are no structures in mind. Rather, I show that we can go about our research in a very different way that takes into account everything that the members to a setting themselves make available to each other (a) to achieve the object/motives that orient what they do and (b) to go about the process of this achievement. Of interest in such an account are ‘knowledge’, ‘thoughts’, and ‘intentions’ only to the extent that members themselves make them available to and for one another. Only this is of interest because solely what they have and make available orients their every next move.

The Learning Paradox

At the time when I originally started the research in my own classrooms, I was not yet thinking about the challenges that the learning paradox posed to educators. In fact, I had not yet heard the term at all, though I know today that Carl Bereiter had published his review article a few years before I began my classroom research. However, perhaps because I was transcribing all my videotapes word for word within a couple of days of recording them, I had the opportunity to see closely what was happening. I began to notice that students’ talk was not so much rationalist and oriented toward a specific goal, namely what I had set out in my planning book following the provincially set learning objectives for my courses. Only a year after I began my classroom research on concept mapping, I read *Contingency, Irony, and Solidarity* by the American pragmatist philosopher Richard Rorty. It was then that I began to ‘put my finger on’ the phenomenon. I was particularly taken by a chapter entitled ‘The Contingency of Language’ in which the philosopher argues that linguistic changes are not the result of ‘act of wills’ but contingently emerge from the praxis of using language. In particular, he writes about how scientific language associated with the Copernican revolution changed as an emergent rather than a planned (constructed) phenomenon: ‘After a hundred years of inconclusive muddle, the Europeans found themselves speaking in a way which took these interlocked theses [from telescopic observations] for granted’. 17

He further suggests that cultural changes do not result from applying criteria and that we should look neither within ourselves nor in the (material) world for finding decision-making criteria that mediate the emergence of a new idiom. I was taken by this description, for it describes what I have been seeing. Students appear to evolve new ways of talking rather than intend to speak new languages. One word in particular was fit for denoting my observation: muddle. In my classrooms, the students clearly did not talk the way in which they talked outside, in the dorms, during the sports activities that we participated in together. They did not talk like physicists either, in the way I (the teacher) might have expressed myself about a particular phenomenon or in the way I might have contributed to a conversation concerning some concepts. I heard such ‘muddle’, a term I always used in a positive sense as a necessary language from everyday speak to science speak, in the dorms when ‘the boys’ in the residence I co-supervised discussed Stephen Hawking’s *A Brief History of Time*. Later I came to prefer the term Sabir, because it does not have the same negative connotations as muddle. Sabir are hybrid languages that Mediterranean merchants spoke—bringing resources from any and every language that they could draw on—in and for making a deal. But I did not grasp the full implications of my observations. It was only through a continued interest in phenomenological studies that I investigated learning through the eyes of the learner and eventually came to understand the phenomenon that I now denote as the learning paradox.

Ontogenetic Perspectives

One event in particular ‘pushed me over the edge’ and eventually allowed me to recognize the fundamental contradiction. During a stay in northern Germany as a fellow of the Institute for Advanced Studies, while analyzing videotapes featuring tenth-grade students in the process of learning about static electricity in a specially designed hands-on unit, I decided to put myself through an experiment in which I would closely record what I learned. One day I went on a trip along roads that I had never taken before and recorded, after returning home, everything I remembered to have seen. On the next day, I wrote down what I remembered from the previous day and then cycled the same one-hour circuit again, sometimes attempting to predict what I would see around the next corner and again noting into my research log everything I remembered once I returned home. I did this precise circuit for 20 days in a row. On the seventh day I had a striking experience. (I had many similar experiences over the three months of my fellowship.) I was close to home when I noticed two giant feed silos close to the road. I was flabbergasted. I had passed the same spot for six days in a row, intending to learn as much as possible about the way, and I had not seen these, what I now took to be impossible-to-miss towers in the landscape. My first thought was that I could not have intended finding the twin silos in my ‘hands-on’ course, because I did not know of their existence. Despite my ‘hands-on’ experience in their vicinity, I did not notice them. More so, I thought, if a teacher had given me a test about the towers after one of the first six days, I would have flunked miserably. The twin silos are nowhere in my research log until that seventh day when I first noticed them. And yet, to the teacher these silos would have existed as really and as impossible-to-miss as they existed for me within a fraction of a second after they began to exist for me.

This is not a singular experience. Just a few weeks prior to writing this paragraph, I am returning home from the university along a road that I have taken for more than ten years. All of a sudden I am struck. I see a church (Fig. 2.1), which evidently has been in this place for a considerable amount of time, certainly for longer than the ten years that I have been passing by here. Yet this is the very first time that I notice this church. Again, I could not have intended perceiving and learning about the church because I did not know it was there. Moreover, if I had taken a test related to the presence of this church, I would have flunked miserably. I have not seen the church previously, although I am a keen observer of the everyday world because of a deep concern for all aspects of knowing and learning around me. It is not that I have come by here quickly, by car, though I have done so, too: For the past 10 years I have been cycling along this road without seeing the church that so clearly sits right next to the road.

The learning paradox can be articulated in terms of the perennial question of how structures of new and higher complexity can emerge on the ground of less complex structures. As Carl Bereiter shows in his review article written more than 20 years ago, Piagetian and radical constructivism have not been able to provide answers to this fundamental quandary. Culture in itself cannot provide an account of this quandary, because even if adults helped children to achieve skills that they subsequently internalize, the question remains how this internalization would take place. As experiments
in the cultural-historical tradition have shown, thought can emerge where there is no thought when there are mediational processes that allow not only engagement and participation but also enable a reflexive turn in which these processes turn upon themselves. Thus, the research conducted by the Russian psychologist Alexander Meshcheryakov shows that deaf-blind children, who heretofore merely vegetated, were able to develop normal levels of thought (and even attending university).\textsuperscript{18} His experience shows that it is not sufficient to engage the children in some tasks but to allow them to become aware by reflexively turning upon the task and the tools involved. Thus, one of the ways in which the children become conscious of tools (objects) as tools (objects) is by allowing them not only to learn to eat with a spoon but also to explore the very spoon that they eat with. This is a nice analogy for the way in which I present language and language learning in this book, as a recursive system. It is not sufficient to allow students to engage in talk about something, they need to engage reflexively and recursively in talking about their talk, in using language for talking about and manipulating language. It is in this reflexive turn of language upon itself that it reaches higher levels of complexity.

When we look at the videotapes and through transcripts such as the ones I feature here (see, e.g., the transcript of one concept mapping task in the Appendix), we see students accomplish a task where there is no evidence at all that they engage in the planful and ‘intentional’ ‘construction’ of ‘a specific piece of conceptual knowledge’. The verb ‘to construct’ is transitive and requires an object, something to be worked

\textsuperscript{18} Alexander Meshcheryakov, \textit{Awakening to Life: On the Education of Deaf-blind Children in the Soviet Union} (Moscow: Progress, 1974).
with and the focus of the doing, and a motive/goal/intention that serves as an aim to be worked toward. The verb describes the work on a concrete object to transform it so it takes another, the intended form. However, the knowledge that the curriculum sets as the goal is unavailable to students, it is whatever students will have acquired as a consequence of the curriculum. There is no doubt that the students whom we follow in this book through one concept-mapping session—Ken, Miles, and Ralf—learn to speak physics while making a concept map. But they do not construct the new forms of language, because to do so they would need criteria for deciding whether one construction is better than another—like carpenters need plans so that they can decide which material and tool to use to make precisely the house that their customers want. In the acquisition of new knowledge, such criteria cannot exist because it is only with our new ways of talking that we evolve that we can specify what it is that we learned. But, and this may sound contradictory, the choice for which language to use—i.e., which language game to play—is not arbitrary either, because there is a path-dependence to the evolution of language where, to paraphrase Rorty, we loose the habit of using certain words and gradually acquire the habit of using others.

The concept of construction and the associate verb to construct are limited and limiting to attain a truly productive and generative way of thinking about learning generally and the learning paradox particularly. When I think about construction, I think about building homes and parts thereof—I recently finished an entire basement, including the walls, sound insulation, bathroom, and vapor and sound barriers. I am familiar with construction work. The builders constructing a house find themselves with clearly distinct raw materials that already have their intended uses. There is the concrete that is going to be used to pour a foundation, 2-by-4’s to frame the walls and ‘4-by-8’ sheets of plywood or particleboard to produce the shell; and there are beams and materials to build the rafters for making the roof, to be covered with some form of shingles. The builders know and therefore can intend the final product. They have a plan. They can have a plan because of their experience with the distance that exists between projected and real outcomes. They construct the building and, because they have a plan, they know when they have erred, and when they have to revise a job. They can assess the final product by comparing it to what is on the paper.

Students are in a situation very different from construction workers. Students do not construct knowledge and frameworks in the way the workers do. Students do not know what the outcome of their activity will be and therefore do not and cannot engage in the intentional construction of the target knowledge. They are not like architects either, who have certain fundamental elements that they put together to derive the plan for a building. This would not be learning new things but merely differentiating what is already known. Instead, students find themselves in the position of bricoleurs who take the materials at hand to see how they can solve with it the problem they have. They are involved in creative acts where they cannot know their creation until after it has occurred. In chapter 10 I further articulate a phenomenological perspective on the creative act of painting as an analogy for learning something new.

In his discussion of the contingency of language, Rorty also draws on the analogy between language (‘vocabularies’) and tools to articulate the major drawback that this analogy comes with. His conclusion underscores my point about the problem of the
constructivist perspective. Thus, ‘[t]he craftsman typically knows what job he needs to do before picking or inventing tools with which to do it. By contrast, someone like Galileo, Yeats, or Hegel (a “poet” in my wide sense of the term—the sense of “one who makes things new”) is typically unable to make clear exactly what it is that he wants to do before developing the language in which he succeeds in doing it. His new vocabulary makes possible, for the first time, a formulation of its own purpose. It is a tool for doing something which could not have been envisaged prior to the development of a particular set of descriptions, those which it itself helps to provide’. 19

To further elaborate on the distinction between constructing something and building something as a bricoleur, let us look at drawing as an analogy. We can decide to draw/paint a horse. The two verbs are transitive, which means we have some vision of what the outcome will be, then take a pencil and paper and work toward producing such an image. We can compare the outcome to what we had intended or to a picture of a horse or even to a real horse. We may decide that our drawing is well done or needs revisions. On the other hand, we may doodle. But the verb ‘to doodle’ is an intransitive word and therefore can be done without an object. The result of such ‘art’ is something that emerges from unintended and conditioned movements, like a Jackson Pollock painting. Students therefore are more in the situation of a Jackson Pollock using paint to evolve a painting that he himself did not anticipate the outcome of. Not only Pollock but even the classical painters, when they were after creating a new way of looking at the world, could not tell beforehand what they needed to paint to make this new way of painting happen. It is only when they had painted that they could recognize that they had done something new. 20

To understand learning we have to come to grips with the question of the horizon that separates that which is known from that which is unknown, that is, the horizon that separates the clearing and the darkness beyond. The very question of the intent to learn requires the acknowledgment of a world beyond the horizon of the clearing, a world that is not yet known but that can open itself so that we can see what is unseen (rather than the invisible). This horizon itself holds the key, because it implies as a priori the very knowledge about the unknown. The horizon as horizon generally is not thematic. When I recently read about some South American Aymara tribe where people point a finger over the back rather than toward the front when talking about the future 21, I realized the problem Westerners have of getting away from learning as a purely intentional act. We point forward and toward a horizon, and therefore, what we want to do is ahead of us. To the Aymara, however, the future is behind the back, so that they can think of the future as bringing that to view that unavoidably is unseen and cannot be anticipated. It is precisely the historical and phenomenological methods that make thematic those aspects of everyday life accessible to the non-scientific ground upon which any transformation into the scientific occurs. The same aspects serve as material that becomes what we subsequently name scientific; and it is the tool

19. Rorty, op. cit. note 17, 12.
with which the transformation is accomplished. Language, because it is the most important structure in our lives, plays an important role in the processes by means of which we overcome the learning paradox in any practical situation. The existence of language is made possible by the empathic community of human beings among each other, which has as its correlate the world of objects, and, therefore, an objective world.

**Cultural-Historical Perspectives**

When we theorize learning, it might help not to think about students in the world today but about the first time ever that a human being spoke or about the first time ever someone did geometry. How did language emerge if it takes at least two individuals to understand, the speaker and the listener? How did geometry get off the ground in a non-geometrical culture? How did science ever get off the ground in a cultural context through and through marked by traditional ecological knowledge (later Aristotelian thought) and, from the perspective of present-day science, through and through non-scientific? In the context of describing the crisis of the European sciences, Edmund Husserl suggests that a true science can only be founded when the original concepts are fixed in writing: ‘In the first verbal collaborations of the beginning geometers lacked understandably the need for an accurate fixation of descriptions for the pre-scientific ur-material and of the ways in which related geometrical idealities emerged and the for the latter relevant “axiomatic” statements’. Here the ‘raw material’ is understood as the way in which people understood geometry prior to the first formal geometry: their proto-geometric concepts. Husserl describes the situation how geometry can emerge from pre- and even non-geometric thought. He suggests that a science can emerge only on the condition that it is written down so that it can both be reflected upon and that its idealities can be reproduced infinitely into the future. The concept-mapping task puts the students in a situation similar to the one in which early geometers found themselves. Students are asked to produce a system of statements with given concept words on the basis of their pre-instructional language and beginning language. It is in and through the fixation of this ‘ur-material’ in a way that it preserves the very essence of talking science. The emergence of geometry talk from something that is non-scientific requires there to be processes that allow any form of non-scientific talk to turn into scientific talk, both on cultural-historical (phylogenetic) and on ontogenetic scales. This problem of the ‘ur-constitution’ of geometry therefore pertains in similar ways to all of the sciences. It also allows us to think about the ‘ur-constitution’ of structurally more advanced forms of talking and thinking about scientific phenomena.

How can the original sense of what is scientific about a science be recovered in the practices today? How is the ‘ur-sense’ maintained in the intentional history of sense?

The ur-materials that constitute the first scientific sense, the ur-premises so to speak, derive prior to all science from the lived-in world, which is not a merely material world surrounding the individual like a box but it is always and already a structured cultural world shot through with signification and, above all, a structured world that the individual co-constitutes.

The special problem that poses itself is how some of these students then become scientists themselves and, in so doing, contribute to reproducing the science all the while they are producing it anew, with new theoretical concepts and methods. There is the historicity of the sciences themselves; and the students generally (as members of society that makes science possible) and future scientists specifically develop and in their development both reproduce science and generate its renewal. In and through their participation, culture generally changes, and so does the culture of science specifically. That is, despite all the worries on the part of science educators generally and conceptual change theorists particularly, not only do new generations reproduce science as it has historically developed but also they produce new forms of science that we have not even thought about only a few years ago. But the same happens to all those forms of language that they term to be due to ‘misconceptions’. This leads us to another question: How is it that recent generations do not have to reproduce the entire history of science, that they do not have to return to the basics to work their way through to current thinking, but pick up on forms of science that did not even exist some 100 years ago? Again, the approach I take here much better than the conceptual change perspective explains the continual transformation of science all the while students struggle in school with developing forms of discourse that appear to have been those of the past. Throughout this book I show how a concept word becomes more complex and contains or indexes other forms of talking like a black box.

Black boxes are used whenever a piece of machinery or a set of commands is too complex. In its place cyberneticians draw a little box about which they need to know nothing but its input and output. An example that I have always liked—about how language becomes simpler because new forms black box old forms—is that of the relationship between electric fields, magnetic fields, electric charges and currents, and magnetic poles. It took the physicist James Clerk Maxwell an entire book to develop the ideas and equations to show the relations that integrated everything physicists knew about electricity and magnetism during the mid-19th century. Today, one can find the key issues Maxwell developed in his book in any undergraduate textbook: four tiny equations (Fig. 2.2). A physicist can, but does not have to, unpack each symbol, each letter can but does not have to be unpacked.

\[ \nabla \cdot \mathbf{D} = \rho; \quad \nabla \cdot \mathbf{B} = 0; \quad \nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}; \quad \nabla \times \mathbf{H} = j + \frac{\partial \mathbf{D}}{\partial t} \]

**Fig. 2.2.** Four tiny little equations contain all the knowledge about electromagnetism known during the mid-19th century, which initially and in different form took James Clerk Maxwell an entire book to develop. The point is that for a physicist each symbol, each letter can but does not have to be unpacked.
historical period can now be expressed and used in four tiny equations that are an integral part of the physicist’s, applied mathematician’s, or engineer’s language. Black boxes can be used without requiring acquisition or skills that are embodied on their inside. Black boxes therefore constitute one of the forms in which the language of a field becomes more complex. New generations do not have to learn the skills that are required on the inside of the black box, but they need to evolve the competencies to use the black box as a tool. In this way, new generations immediately operate with language and practices that are more complex than those of generations past. But black boxing does not get rid of the history that produces it, so that ‘the curse of five thousand years of culture [comes to be] encrusted on each movement, each word’.  

In concept mapping, the students use language to evolve statements that they have never made before, that is, they use language to evolve language. Language as they find it today, which contains ancient forms of talking about things in new and more economic form, is the ground, the material, and the tool of concept mapping. New generations of students find a language in which today’s forms of talking are encapsulated and do no longer have to be made explicit. Students are not, and do not have to be, asked to reproduce the science of Aristotle or Galileo but the science of today embodies their achievements in its very core. To understand learning both at ontogenetic and cultural-historical scales, we need to understand the real problem, which is one of inner-historic nature: the problem of the way in which sense itself comes about in the practical engagement with a world populated with others and with objects.

Scientific language therefore becomes increasingly complex as older forms of talking/writing come to be enfolded into new forms of talking/writing. There is an abyss unfolding between ‘the essence of the new dimension and its relation to the old familiar field of life. Nowhere else is the distance so great from unclearly arising needs to goal-determined plans, from vague questionings to first working problems—through which actual working science first begins’. Against this abyss all other difficulties in understanding the essence of learning are minor. This abyss has been discussed in the learning sciences literature under the term of learning paradox. How then can we get out of the learning paradox, out of any learning paradox? One process that lets us get off the ground as if we were lifting ourselves up at our own shoelaces is called bootstrapping. This method comes in various guises in different fields, including computing, physics, or business. The term is generally used to refer to processes that can unfold without external help, that is, to processes that are self-sustaining.

**Bootstrapping**

The term bootstrapping is used to denote the situation where a system develops into a structurally more complex one by its own structurally less complex means. It is a way

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23. Eco, op. cit. note 1, 44.
for overcoming the chicken-and-egg problem, which requires a chicken to lay the egg from which the chicken has come. The closest analogy for the present purposes may be one from computer programming, where the problem presents itself in the context of writing a compiler (assembler), a program that translates English-like instructions into machine-readable code, in the target language. That is, the challenge is to write a translator in the language that it is to translate into but that does not yet exist (i.e., the classical chicken-and-egg situation). Literate Programming is one approach that successfully deals with this chicken-and-egg situation of writing a program and its documentation simultaneously. In one example, CWEB, the programmer works with two languages simultaneously, TeX for formatting and C for programming. The typographic dimensions of TeX allow the exposition and explication of the program’s structure, whereas C provides the tools for specifying the algorithm.

If the learning of a language at the individual and cultural levels is possible, then this possibility has to be internal to language. That is, change has to be possible from within the perspective of the learners and from within the language they use rather than as conceived by scholars. Change has to be possible and available as a transformation from within the consciousness of the speakers of (prescientific) language. Students themselves achieve the possibility of creating a ground for scientific language through the powers embedded and embodied in the language they use, in its own powers. And they do so through original self-reflection, which itself is a possibility of language. In the process, their (‘naïve’) language (and world) comes to be transformed into a phenomenon or, more accurately, into a universe of phenomena. The beginning of the process, of course, is necessarily one of experiencing, talking, and thinking in naïve self-evidence.

At the same time, the development of new forms of language (vocabularies, dialects, idioms) does not come from a simple fitting of old vocabularies. It is not a melding or fitting different pieces of students’ everyday language. That is, the trial-and-error creation of a new, third vocabulary is not a discovery about how old vocabularies fit together but rather it has to be an evolution of something new that constitutes a creative transformation of what currently is available. This is also why an inferential process cannot reach a new language. We do not get to the new by starting with premises formulated in the old vocabularies. Creations such as new languages are not the result of successfully fitting together pieces of a puzzle but are the result of a creative endeavor where something new and unanticipated emerges.

In natural language learning—talking physics in a 12th-grade high school classroom being one of its local dialects—language is the material, the tool, and the ground upon which new forms of language are produced. It is only as a recursive system that language can transform itself. As learners, we are all thrown into the vernacular of our community, and its discourse generally is different from the discourse that characterizes the scientific discourses of textbooks. This local dialect of physics, characteristic of textbooks, cannot be reached from existing language by means of a simple, linear process—e.g., more or less sudden replacement of old forms of speaking by new forms of speaking. What we need to understand and theorize is how learners can and do bootstrap themselves from their everyday ways of talking into the local dialects of any field, here exemplified by the local dialect of high school physics. The transcripts
(as the audio- and videotapes) that I use here generally and the introductory transcript fragments specifically provide evidence for the multiple functions that language has in learning processes: (a) there are speakers talking to organize what they do, that is, they use language to manage their collaboration; (b) at a second level, the students talk about their topic, here the concepts written on paper slips and the hierarchical relations between the concept words; (c) they make the situation one in which schooling is reproduced and transformed; and (d) all of this occurs in and out of language, which constitutes the very ground that makes all of the other functions possible.

A Dynamic Approach to Language, Culture, and Learning

Central to Mikhail Bakhtin’s writing is the concept of dialogism. Sometimes taken literally, researchers use the term to refer to the fact that two or more people in a classroom engage one another in speaking: in a dialogue. But this is not at all what Bakhtin is concerned with. ‘Dialogue is studied merely as a compositional form in the structuring of speech, but the internal dialogism of the word (which occurs in a monologic utterance as well as in a rejoinder), the dialogism that penetrates its entire structure, all its semantic and expressive layers, is almost entirely ignored’. There is therefore an internal relation of the word to itself, an internal dialogism. This internal dialogism involves different moments of the word. These moments derive from the dislocation or diastasis within the word, which allows the latter to stand both for itself and something else: a material thing and a pointer to or marker of something else.

The dialogism internal to the word, this inner contradiction, expresses itself in various phenomena—much like the inner contradiction of light expresses itself such that it sometimes has wave character and at other times it has particle character. These include the fact that there are different senses that a word can take, that a word can be defined and explicated in other words and this new text is said to pertain to the same topic, and that the same word takes different senses for different people (e.g., speaker and listener). This makes the word undecidable in at least two ways: (a) one cannot ever decide which of the possible (dictionary) senses is relevant until a specific situation is identified and (b) one cannot ever decide what the thing or phenomenon is, that is, in the utterance of the word, marked, re-marked, and remarked against the ground. That is, the undecidable is made from the exact superposition of the word’s blind spot and its focal point, the center of its saying. Another effect of dialogism is the fact that the word encounters an alien aspect in the object, a thing that is different from but denoted by the word. A third effect is that each word is not only marked by who speaks but also by who listens. The word is directed toward another, with an anticipated effect made available in the response. That is, the word is a directed answer-word, because it provokes an answer, it anticipates an answer, and it structures itself in the direction of an answer. I concur with Bakhtin who writes that there are two faces to each word in its double determination as coming from someone and being

directed toward someone. It arises as the interactional product of the speaker–listener conversation. Active understanding of the word therefore is itself dialogic, because it projects the germ of a response.

The most profound aspect of this theory and the one least taken up in the educational literature is that of the non-self-identical nature of the word. The word cannot be identical with itself because it is dialogical right at its heart, and therefore constitutes difference as such. The contradictory nature of the word (language) has been taken up in philosophy during the latter part of the 20th century. For example, Paul Ricoeur articulates for us to the enigma that one can always say the same thing differently and at the same time, the identical sense, which is to render two equivalent versions of the same statement, is forever unfindable.\(^{26}\) Similarly, Jacques Derrida formulates the inner contradiction that derives from the dialogic nature of the word in two antinomic and incompossible propositions that are contradictory not only between themselves but also within themselves:\(^{27}\)

1. *We only ever speak one language.*
2. *We never speak only one language.*

The incompossible nature of the two statements, which actually constitutes the very law of translation, comes from the facts that (a) if we speak only one language, no translation is necessary and (b) if we never speak only one language, then even our mother tongue cannot be pure. There is therefore an active division within language, within every word, that is the very source of dialogism. The incompossible pair of statements also throws into relief a contradiction in Bakhtin’s own writings generally and in his use of the word monologic particularly.

Bakhtin appears to contradict himself in simultaneously claiming that the word is dialogic and that there are monologic utterances. In the educational literature, the term of the monologic utterance is frequently applied to situations where teachers talk, as in a lecture, and students do not have opportunities for actively engaging in the conversation. Derrida elucidates the issue by combining the two points. First, there appears to be a monolingualism where all language becomes translatable, understandable, and therefore constitutes the hegemony of a *One.* Second, and completely consistent with Bakhtin, we never speak only one language, even in the single-word utterance. Thus, theorists of bilingualism make the point that there is no such thing as the language and no such thing as absolute monolingualism.

Dialogism leads us to understand the continual translation right at the heart of every language, dialect, or idiom. Thus, understanding involves at least two interlocutors at the heart of a speech community, which, though not completely foreigners with respect to one another, are other with respect to one another. This otherness requires an internal translation. We get to the same position if we think that an authentic understanding always has to be active and always already contains the design of a response. That is, at issue is that understanding is not just the utterance but, because of this additional design of a response that overlays itself and modifies the utterance, there is


transformation and translation. In active understanding, each salient element of the utterance that is imbued with signification and the utterance as a whole are transferred into the active setting of the response. It is precisely the setting that reduces the polysemy of and inherent to the individual word to a specific, singular sense. This provides an explication why monolingualism always is the monolingualism of the Other, the listener, who reduces possible polysemy to a singular hearing. Within this new unit of the intelleced utterance, there is a new form of polysemy, where what has been said can be heard in different ways. Here it is the setting that reduces the many different senses of the said and the ear of the other to the one sense that marks signif-
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cance at the instant. But even in the setting, ambiguity that results from polysemy is not reduced to the One. We know this to be the case because of all the misunderstand-
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ings that we may experience on a daily basis whenever we intend to say one thing and others hear us say a different thing or when two different hearers hear us say a differ-
et thing simultaneously, that is, when they disagree about just what we have said.

The concept of monologism (monolingualism) is a contradiction, because every word is already dialogical and every utterance is spoken for the benefit of someone other as much as for oneself. The contraction is apparent in the fact that I have only one language, and this one never is mine. It is language that speaks, as much or more so than I. My own language is a language that I can assimilate because there is always something foreign in it. My language, the only one I hear myself speak and agree to speak, therefore always and already is the language of the Other, a language I have heard prior to speaking, a language I hear and speak simultaneously. That is, even if I mobilize the word of another for my own intentions, it remains the word of the Other, who not only is the source of my language but also the anticipated recipient. Any word, utterance, or language always and already bestraddles speakers and listeners, authors and audiences, and original works and their translations.

Signification and Theme

Bakhtin’s theoretical framework is built upon concepts that he derives from the French-writing Swiss linguist Ferdinand de Saussure, whose main concept is that of the sign, consisting of the signifier (Fr. signifiant) and the signified (Fr. signifié). The two relate as signification (Fr. signification). The signifier is the vehicle, the material body of the sign; the signified the idea or concept that it stands for. A sign, in this approach, therefore has two planes, a material one and an ideational one. That is, a word always has two planes: There is always some material body that gives shape to the signifier and there is always the ideational plane that gives the word its sense. These two planes cannot be separated; they always exist together. This two-aspect nature of the sign fits well with the dialectical materialist approach underlying the writing of Bakhtin and the members of his circle. In a strong sense, there are no signs as individual pure entities that one might denote by the term ‘sign’. For Bakhtin, there are only sign functions or significations and, as for Martin Heidegger, sign and signified arise together from the process of signification. At its lower limit, signification gives us the
dictionary sense of a word, which can appear in the form of (a) a sound complex that we hear in a particular way, (b) traces of ink on paper or other material, or (c) some image.

This double nature of the sign (word) is the source of dialogism. It is the fundamental form of dialogism itself. Bakhtin constructs his approach to language on the model of Karl Marx’s treatment of political economy in *Capital*. For Marx, there is a foundational phenomenon, commodity. A commodity embodies value. But experience shows that for one person a commodity has *exchange-value* whereas for the other person involved in a barter trade, the same commodity has *use-value*. Thus, a seamstress who has finished a shirt may use it to get some bread so that her family has something to eat for dinner. For the baker, on the other hand, the same shirt is use-value. For the other commodity involved in the trade, the relations are the reverse. The bread is exchange-value for the baker but use-value for the seamstress. There are therefore two sides to any commodity, and which side is realized appears to depend on the perspective. Now Marx says that commodity expresses itself as both use-value and exchange-value because it is *both at the same time*, it embodies an inner contradiction. It is like the light discussed by the students in this book, which exhibits wave character in some experiments and particle character in others.

Taking this approach concerning the double-nature of the word provides Bakhtin with the same possibilities that the contradictory nature of value offered to Marx. The inner contradiction is the source for development and change. Just as in Marx’s *Capital* each barter exchange developed exchange forms until the capitalist economy of Marx’s 19th-century England emerged, each utterance develops language in Bakhtin’s system. The resulting change is the source of the development of any language including its genre, and, in fact, the development of the genres themselves. Languages continually renew themselves in the very process of speaking (writing), and as soon as they are no longer used, they become ‘dead languages’. That is, language lives in use, and in use undergoes continuous and simultaneous death and rebirth—a major theme in Bakhtin’s writings.

Opening any dictionary one will see that there is more than one sense in which a word can be read or heard. We can find the same material body (signified) participating in different settings with different significations or sign-functions. This gives the sign a spectral nature, because any signifier can be associated with different signifieds and therefore significations (sign-functions). Each time a word is mobilized for a particular intention that is itself a function of the setting it will realize a different possibility from the spectrum of significations. Thus, Bakhtin asks us to ‘imagine the intention of such a word, that is, its directionality toward the object, in the form of a ray of light, then the living and unrepeatable play of colors and light on the facets of the image that it constructs can be explained as the spectral dispersion of the ray-word, not within the object itself . . . but rather as its spectral dispersion in an atmosphere filled with alien words, value judgments and accents through which the ray passes on its way toward the object’. 28 All of these possible significations are but potentialities. Once the signifier (word) is uttered in a social situation, the context mediates and

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modifies the signification. In fact, in context, the signifier–signified relation together with all the other possible words constitute the theme. To Bakhtin, the theme constitutes the highest degree of the linguistic signifying capacity. In a strong sense, only the theme signifies in a determinate manner. Signification is the lowest degree of linguistic signifying capacity. Signification in itself means little by itself, it is but a linguistic potential, a possibility to signify. Therefore, ‘no living word relates to its object in a singular way: between a word and its object, between the word and the speaking subject, there exists an elastic environment of other, alien words about the same object, the same theme, and this is an environment that it is often difficult to penetrate’.29 The setting and the word form something like a piece of cloth, they constitute the woof and the weft that cannot be separated lest the cloth be destroyed. Theme as thematic unit implicates the speech context. That is, the thematic unity of an utterance is determined not only by the linguistic forms that enter its composition but also by the nonverbal aspects of the setting. Ultimately, therefore, what is marked, remarked, and remarked is the theme: it is what matters and drives the unfolding conversation.

Serious difficulties and problems in English-language scholarly circles derive from the fact that Bakhtin’s term ‘signification’ that is of Saussurian origin is often translated into English by the term ‘meaning’ but also into other words. But clearly, the translation of Bakhtin’s own definitions suggest that ‘meaning is the lower limit of linguistic significance. Meaning in essence means nothing’. Signification, on the other hand, is a relation between the signifier and the signified, not a thing, the translation itself, which follows requests such as ‘What do you mean by . . . ?’.

The theme constitutes a dynamic and complex system of interdependent signs that parallels and refracts the conditions of a given instant. Thus, the ‘utterance “what time is it?” has a different sense each time it is used and, consequently, according to our terminology, another theme that depends on the concrete historical situation” (historical at the microscopic scale) in the course of which it is uttered and of which it in fact constitutes an element”.30 That is, the theme is the ideological parallel that refracts (rather than mirror-like reflects) the material world. In this way, each utterance, as thematic unit, becomes situated and, in fact, irreproducible. Theoretically, this would not be satisfactory to a dialectical materialist approach. Therefore, there also is something repeatable about the utterance, which is its sense, that is, the relation of the signifier (sound envelope, heard as word) and the signified. Signification, therefore, is the lower limit of the signifier–signified relation and describes the relationship between a word and its (dictionary) sense. The theme is indivisible, whereas the signification associated with an utterance can be analyzed into a sequence of significations related to the linguistic elements that make the utterance. This precisely is the kind of analysis that Jay Lemke provides us with in Talking Science, a compositional analysis of the various signifying elements within an utterance and in a complex of utterances. An informal thematic diagram a la Lemke would look like the concept map that my students produced as a result of their task (Fig. 1.2).

Considering the upper limit of linguistic signification (theme) takes us to investigate the sense of a given word under the conditions of a concrete utterance in a concrete setting. It is precisely here that we need careful, descriptively adequate ethnographic studies of the context, on the one hand, and the way in which interaction participants themselves hear what their interlocutors are saying. Rather than imposing external ways of hearing, to understand why a conversation develops as it does, we need to attend to how the participants themselves take up what others are saying and doing with their respective utterances. In each second turn, which also is a first turn for the turn that follows, an evaluation occurs for the purpose in the situation. There is acceptance, rejection, or even creatively mobilized uncertainty any one of which moves the conversation a bit ahead, continuously transforming language in the process.

**Dialogism, Heterogeneity, Development**

As a result of the dialogism within the word, there are other phenomena of doubling that occur. Any single word exists for a speaker not in one but in three aspects. First, it is a more or less neutral word of a language and therefore belongs to everybody and nobody (‘language speaks’). Second, every word also is an Other’s word. It is this generalized other from whom the word has come to me. The word therefore belongs to another person. It is filled with echoes of the utterances that others have produced, for millennia, with the echoes of their voices continuing to resound in the word. This aspect has been picked up in the feminist and critical literature, which has shown that specific words serve the reproduction of a patriarchic system and male-dominated society. Third, each word also is my word, for, since I am mobilizing it in a particular situation, within a particular orientation toward what to say, it is already imbued with my expression. This last type of word is the only one attended to in our field.

We can always say the same thing differently. This is what we do when we define words in dictionaries or, in everyday conversations, when we say what we really mean without having said so. We find, in this manner, on the inside of our own language community, the enigma of the same, the signification itself, the unfindable identical sense, which is supposed to render equivalent the two versions of the same thing. But such translations do not always provide the same content for it is precisely here that we find the origin of misunderstandings and miscommunication. The same word may mean differently and different words are taken to mean the same. But a word is never the same. A language therefore always is a mêlée of languages, always is a Sabir, containing both foreign languages and foreign words from the same language. Like in all mêlées, these languages are not identical with themselves. They are heterogeneous, they are hybrids, meaning the same with different words and meaning differently with the same words. In the more poetic words of the modern-day dialectical philosopher Jean-Luc Nancy, the continual working and reworking of language is expressed thus: languages ‘cannot be added up. They encounter one another, mix with one another, alter one another, reconfigure one another. They culture and cultivate one another,
prepare each other’s ground, irrigate and drain another, plough one another or graft themselves on the other’. 31

Having laid the ground that grounds the inquiry I evolve further the idea of the nature of language in learning over the course of the following four chapters. These four chapters take as their objects four consecutive parts of the conversation over and about the concept-mapping task. The first three parts constitute an opening, a six-minute conversation with the teacher, and the completion of the placement of the paper slips and its transcription onto paper up to the point where the students announced that they have finished. The fourth part consists of the moments when the students transcribe and finalize their map on paper. The corresponding chapter 6 develops language and learning issues while following the students through the final part of the session, the construction of the lines linking concept names and the choice of verbs written on the lines so that statements are produced.