

1 Language, «meaning», «mental representation», and «conceptions» in STEM research

This book is about language in STEM research and about how it is thought about and theorized: as something that somehow refers to something else not directly accessible. This something else often is named «meaning», «mental representation», or «conception». These underlying, explicit and implicit (folk) theories of language, as considered in current STEM discourse, are out of joint. These theories constitute a problematic way of thinking about language; and they are inconsistent with the *pragmatic* approaches that we have become familiar with through the works of K. Marx, L. S. Vygotsky, M. M. Bakhtin, V. N. Vološinov, L. Wittgenstein, F. Mikhailov, J. Dewey, R. Rorty, and J. Derrida, to name but a few. All of these scholars, in one or another way, articulate a critique of a view of language that has been developed in a metaphysical approach from Plato through Kant and modern constructivism; this view of language, which already was an outmoded view for Wittgenstein in the middle of the last century, continues to be alive today and dominates the way language is thought about and theorized. However, the consensus of the mentioned scholars is that there is nothing *behind* language—no «meaning», «mental representation», or «conception» in the closets of language. There is but language itself. Such a view should be of interest to STEM educators, because they no longer have to think about «ideas», «meanings», «conceptions», or «mental representations» that might be inaccessibly *behind* the students' words and how to work with them. Rather, the objectively available language constitutes the very ground, topic, resource, and tool with and about which (societal) intercourse is conducted and produced. In fact, it is this quadruple role of language as ground, topic, resource, and tool that has remained untheorized because STEM educators focused exclusively on the representational role of language.

For several years now, I have either not used the term «meaning» or only used it within quotation marks. Similarly, after having returned from doing my PhD into the classroom, I found the talk about «mental representations» useless in the face of what I had to do as a teacher: listen to students, engage with students, and foster them to express themselves in ways that STEM educators consider competent scientific or mathematical discourse. After having conducted years of research and close analyses of body and language in classrooms and the workplace, as well as

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having done extensive readings in the philosophy of language and incarnation as the basis for all forms of knowing, I have come to this conclusion: these concepts and what they entail are inconsistent with my epistemological commitments that are directed toward overcoming the metaphysical ideas underlying the constructivist position that I had staunchly defended for much of the 1990s. I abandoned these metaphysical ideas about knowing and learning because they got into my way of understanding classroom science learning both as a practicing teacher and as a researcher. In the course of time, I have come to realize that «meaning» and «mental representation» are part of the set of pre-constructed concepts that social scientists have taken up from the everyday world without having subjected them to categorical analysis. Critical psychologists and sociologists alike have warned us—and continue to do so—of the dangers that come with the pre-constructed concepts that beleaguer the social scientist everywhere. When social scientists use concepts, they in fact take up entire ideologies; in general, the sciences tend to reify everyday concepts.

When the concepts we use in our scholarly community are not interrogated as to the historical baggage that comes with them, even a critical feminist sociologist not only might find herself at the receiving end of societal processes but also contribute to the reproduction of these processes. An example of this is when the life of a female sociology professor with her child comes to be determined if it is conceived in terms of “single parent family” (Smith 2000). That is, the set of societal (ruling) relations that are sedimented in and inextricably associated with the use of terms have real consequences to our lives. Thus, by understanding herself and her situation in terms of a “single parent family,” D. E. Smith, despite and perhaps because being a sociologist, actually reproduced the societal preconception that single-parent families provide less than ideal contexts for the learning and development of their children. It is only when the very ruling relations—those that are embedded in and come with the use of the concepts and the associated ideologies—are interrogated that a transformation of the relations between the mother and the school and other societal institutions can be transformed. That is, when we do not interrogate the history of the concepts we use, we may contribute to the reproduction of the very ruling relations that need to be transformed to improve our life conditions. The problem with the pre-constructed classificatory notions such as «meaning» or «mental representation» is that STEM educators are attempting to understand their subject, learning, of which they themselves are a product; the use of such concepts makes us reproduce the very epistemology that we (some of us at least) want to overcome. The danger with using everyday concepts comes from their self-evident character, which “arises from the fit between objective structures and subjective structures which shields them from questioning” (Bourdieu 1992: 235). From this results something like a science that is only partially scholarly because, Bourdieu continues to argue, it “*borrowes its problems, its concepts, and its instruments of knowledge from the social world.*” This science, in turn, “records as datum . . . facts, representations or institutions which are the *product of a prior stage of science*” (ibid: 236, original emphasis).

The upshot of a critical position therefore is to question the categories we use in our work as STEM researchers and teachers to think about and change what we do. There are serious consequences if we do not engage in such critical investiga-

tions. The most important consequence perhaps is that we cannot bring about lasting change in STEM education, because the very problem arises from, but is hidden behind, the ways in which we articulate issues. If this articulation occurs by means of categories that stand outside of the question, then we are unable to deal with the way in which these determine what we articulate and how we articulate it. Not knowing our categories, their origin, and their function leads to the noted fact that we do not really know what we are doing when we say we conduct research.

A scientific practice that fails to question itself . . .

A scientific practice that fails to question itself does not, properly speaking, know what it does. Embedded in, or taken by, the object that it takes as its object, it reveals something of the object, but something which is not really objectivized since it consists of the very principles of apprehension of the object. (Bourdieu 1992: 236)

Science, technology, engineering, and mathematics education, as any other (social) science, requires categories and concepts to establish the theories for their phenomena of interest. However, fairly little if any work appears to be done in our field concerning the fundamental categories and concepts that are in current use. In our field—as in psychology, philosophy, or sociology—researchers by and large operate with commonsense concepts that have been elevated to philosophical and scientific concepts through some refinement and operational definition. This take up of commonsense concepts leads to the fact that “*the preconstructed is everywhere*” (Bourdieu 1992: 235, original emphasis) not only in the everyday world but also in the (social) sciences. Yet to practice a truly scientific endeavor, STEM education researchers, in the same way sociologists and their relatively older science, have to guard against the reification of common sense. This is why STEM educators and researchers, just as other social scientists, have to develop their *own* language: here, “the terminological problem, which requires a complex analysis, takes the lion’s share of a science” (Vygotsky 1927/1997: 289). This should be one of the grand challenges of STEM education, especially in a globalized world where the validity of terms, theories, concepts, and metaphors across languages becomes an issue. Therefore, the

construction of a scientific object requires first and foremost a break with common sense, that is, with the representations shared by all, whether they be the mere common places of ordinary existence or official representations, often inscribed in institutions and thus present both in the objectivity of social organizations and in the minds of their participants. (Bourdieu 1992: 235)

The problem is to know, without assumed presuppositions and prejudices, the object of research of which researchers are the product. If STEM education as a practice does not interrogate and bracket its categories and concepts one by one, that is, if it fails to question itself, it literally does not know what it is doing, as Bourdieu suggests in the introductory quotation to this section. This means that we really ought to bracket even our most cherished concepts and categories.

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Bracketing here does not mean that the concepts and categories are denied or made to disappear: their existence is acknowledged without giving these any place in explaining phenomena. In psychology, there are a few attempts to reconstruct the human psyche bottom up based on functional historical analysis of the psyche generally and of motivation more specifically while avoiding the preconstructions common in our culture. More recently, a step toward such an approach to the teaching of science exists in Germany, where researchers have developed the “model of didactic reconstruction,” whereby the development of curriculum is made a function of learning research rather than based on the basis of disciplinary considerations. But that approach still falls short of the present proposal to engage in a *categorical* reconstruction of the basic concepts. In this book, I use triangular brackets (chevrons) “« . . . »” around a concept word (i.e., «meaning») to emphasize (a) the provisional character of the terms to be reconstructed in this manner and (b) the need, consistent with the argument for a pragmatic approach to language, to look at the work that is being done by and with the deployment of this term. (I place terms in quotation marks when these refer to the use in the texts analyzed.)

One of the core notions of STEM education constitutes «meaning», which, as shown in the next paragraph, appears with high frequency in the science and mathematics education literature. Students, teachers, and researchers are said “to construct/make ‘meaning’” without a clarification of the work that the term «meaning» does or lends itself to do—as I show, it tends to reinforce a mentalist approach to STEM learning. Yet, even more so than with the concept of “scientific literacy,” which seemingly resists definition or is subject to continuous redefinition, there exists a conceptual mayhem when it comes to the notion of «meaning». But unlike in the case of scientific literacy, STEM educators do not work on a categorical construction of such notions as «meaning», «conception», and «mental representation». Without some categorical reconstruction in the context of empirical studies, we may be/remain a “half-scholarly science [that] *borrow[s] its problems, its concepts, and its instruments of knowledge from the social world*” (Bourdieu 1992: 236, original emphasis). Being a product of this world, STEM scientists use, as Bourdieu says, “facts, representations or institutions which are the *product of a prior stage of [their] science.*”

Despite the exhortations of specialists in semiotics and language concerning the problems with the theoretical notion of «meaning», the term and its variations as verb, adjective, adverb, and gerund may be among the most-used in the STEM education literature. For example, a count of the occurrences in the 49 articles from the 2011 volume of the *Journal of Research in Science Teaching*—which I subject to an extended analysis in chapter 2—reveals 281 uses of the noun *meaning* or its plural form, 104 uses of the adjective *meaningful* and the associated adverb and 4 uses of its negation *meaningless*, and 241 appearances of the verb “to mean” (mean, means, meant). The term “meaning” and its plural version also figures prevalently in mathematics education, for example, 111 times in *Mathematics Education and Subjectivity* (Brown 2011), a book from which I take many quotations in chapter 4 as examples of the current STEM ideology concerning «meaning» and the «subject». An alien ethnographer trying to understand the discourse element «meaning» and its variations (verb, adjective, present participle, gerund,

adverb) would find a bewildering array of uses, functions, and modifications. The ethnographer may even use the term “conceptual mayhem” to describe the observations related to the practical uses of the term and its grammatical variations. Not surprisingly, perhaps, Wittgenstein drops the term, as much as that of *understanding*, from his considerations of language and knowledge (see first quotation in the *Preface*).

To deal with the intrusion of the commonsense world into the science(s) of STEM education, it has therefore been recommended to *bracket* common sense and the concepts of existing scientific research simultaneously, whether the research concerns consciousness or the order social actors produce and encounter in the social world. Bracketing denotes the action of putting out of functioning of the very concepts that we have the habit of using in a particular context. That is, we are asked to exercise radical doubt with respect to the very discourses and concepts that have become common place. In his own field, sociology, Bourdieu suggests that research “bypasses the radical questioning of its own operations and of its own instruments of thinking” (Bourdieu 1992: 236). In fact, he suggests that in that field many members would consider radical doubt—i.e., the work of engaging in a *reflexive intention*—“the relic of a philosophic mentality, and thus a survival from a prescientific age.” But in the course of doing so, the field of sociology avoids getting to know the instruments of its constructions, and, therefore, he suggests, it “is thoroughly suffused with the object it claims to know, and which it cannot really know, because it does not know itself.” In and with this book, I intend to contribute to a similar endeavor in the science(s) concerned with STEM education by critically interrogating the concepts of «meaning» and «mental representation».

Toward a pragmatic theory

The construction of theoretical categories is necessary to understand the theoretical implications and entailments that these bring with them. Thus, for example, once we draw on «meaning» in the ways STEM researchers commonly do, we also require “shared «meanings»” and “shared «understandings»” to understand language use, as evident in the following excerpts from the 2011 volume of the *Journal of Research in Science Teaching* (JRST).¹

This framework may again appear at first glance to contradict our earlier stated position that there is no single version of the science student role and that each individual may have a personal understanding of the role that exists within a culture of *shared meanings and symbols*. (JRST: 386, emphasis added)

[P]ractice is constituted by a patterned set of actions, typically performed by members of a group based on common purposes and expectations, with *shared cultural values, tools, and meanings*. (JRST: 463, emphasis added)

Based on *shared understanding*, members use joint intellectual efforts and resources to investigate and resolve issues, problems, or questions and to actu-

¹ Because I am concerned with *discourse*, inherently a social phenomenon characterizing a community of practice, I refer to the journal page. In this way, the use of the discourse as a whole and of a particular phrase is indexed to the readers and author/s rather than to the latter alone.

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alize their understanding and meanings. (JRST: 684, emphasis added)

In the first quotation, the individual and the culture constitute opposite poles, whose “personal understanding” is opposed to the “shared meanings and symbols.” Such a description is inconsistent with Vygotsky’s notion of words, language, and consciousness as impossibility for the individual but always already implying the multiplicity of society and its culture. In the second quotation, the term “meaning” is modified by the adjective “shared,” which implies that there are other forms of «meaning», for example, «personal meaning». Returning to Vygotsky, consciousness is impossible for one individual—already the etymology of the word, from Lat. *co[m]n-*, together, with + *sciēre*, to know, suggests that consciousness *always* is being conscious and *knowing together* (Vygotskij 2005). The third quotation again uses the adjective “shared” to modify “understanding,” thereby denoting that there are forms of understanding that are not shared. This flies in the face of the very definition of language as something that we use to modify the behavior of others and ourselves.

In a pragmatic approach, however, we do not need shared «understandings» and «meanings» that are somehow behind the language people actually use in interview or classroom talk. Language use is irreducibly tied to and meshed with situations; and these situations are managed locally (“endogenously”). The initial analysis of the uses of «meaning» presented above shows that it is consistent with, and contributes to producing, a metaphysical theory of knowing and learning. The theory is metaphysical in nature because whatever the term «meaning» denotes is not directly accessible: the words-in-use only point to «meaning», which itself continuously escapes. The very use of the term thereby precludes other ways of researching and theorizing what happens in classrooms, such as when researchers do not seek recourse to anything other than what members to a setting make available to each other. Analyzing and using in explanations only what people *accountably* make available to each other—i.e., we can all point to what they are saying and doing, which is not the case when we *attribute* «intentions» or «meanings»—is a fundamentally pragmatic approach to knowing generally. In this section, I explicate a pragmatic alternative that arises when we conduct the analysis as proposed in the preceding section: we stick to language as it is used and to the social order attended to and made available for everyone else participating in a situation. It is an approach to human life forms that does not require recourse to «meanings», «(taken-as-) *shared* understandings», and «negotiations». I begin by articulating philosophical considerations, move on to situate the theoretical aspects in a concrete example, and then sketch how the research policies of ethnomethodology fully realize the pragmatic approach to practical action.

Language philosophical considerations

Any higher psychological function was external; this means that it was social; before becoming a function, it was the social relation between two people. (Vygotskij 2005: 1021)

Pragmatist philosophers of language agree that to understand social situations we do not need to seek recourse to some mental stuff—e.g., meaning, ideas, or concepts—and conceptual frameworks behind words. Wittgenstein is quite explicit about dropping meaning, as understanding, from his considerations of language, its use, and its functioning in social transaction: “Understanding, meaning, drops from our considerations” (Wittgenstein 2000: 1).² Even cultural-historical psychologists do not need to seek recourse to mental stuff that is behind the words we use, for, as Vygotsky states in the introductory quotation to this section, any higher psychological function is (at some time) external, is a social relation between two people. Moreover, for any child learning something new, these are the social relations of its first experiences *in the present*. That is, these social relations that are subsequently ascribed to higher psychological functions always already are co-present with the latter. Actual, concrete, physical relations in society are the very stuff that subsequently is ascribed to individuals and their higher functions. That is, the dichotomy opposing the inner and the outer is an artificial dichotomy: “There is nothing *other* for us from the outset that would not be our *own*” (Mikhailov 1991: 20). Anything like mind is the result of “a single process” of the mutual generation of what is self and what is other (social).

Pragmatist philosophers of language take issue with the traditional conception of language, which seeks recourse in «meaning» to explain its use: “In the old mode of expression we can say: the essential of a word is its meaning” (Wittgenstein 2000: 8). The traditional conception of language is the core issue deconstructed in *Philosophical Investigations* (Wittgenstein 1953/1997). In the opening paragraphs of the book, the author presents a quotation from St. Augustine’s *Confessions*, and then suggests that the text provides us with a particular way of understanding human language. Augustine says this about the way in which language is learned:

I was no longer a speechless infant, but a speaking boy. This I remember; and have since observed how I learned to speak. It was not that my elders taught me words (as, soon after, other learning) in any set method; but I, longing by cries and broken accents and various motions of my limbs to express my thoughts, that so I might have my will, and yet unable to express all I willed, or to whom I willed, did myself, by the understanding which Thou, my God, gavest me, practise the sounds in my memory. When they named anything, and as they spoke turned towards it, I saw and remembered that they called what they would point out, by the name they uttered. And that they meant this thing and no other, was plain from the motion of their body, the natural language, as it were, of all nations, expressed by the countenance, glances of the eye, gestures of the limbs, and tones of the voice, indicating the affections of the mind, as it pursues, possesses, rejects, or shuns. And thus by constantly hearing words, as they occurred in various sentences, I collected gradually for what they stood; and having broken in my mouth to these signs, I thereby gave utterance to my will. (Augustine 1860: 11–12 [§8.13])

² I elaborate on the difference between *interaction* and *transaction* in chapter 5 (p. 111). In interaction, independently existing “elements” come to relate as part of a whole (e.g., molecule); in transaction, the parts become parts only in their relation to the whole. What a part is can be specified only as a function of the whole, not independently of it (see Dewey and Bentley 1999).

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Here, Augustine articulates a theory where a word stands for something else: something that the elders meant (to say) without actually saying so. Augustine also points out that what is meant but is not directly available is expressed in other ways, “from the motion of their body,” which he calls the natural language shared across “all nations.” He lists a variety of body movements that even today many academics and non-academics alike list among features of “body language,” even though, because of the lack of a clear semantics and syntax, the word “language” in “body language” is actually a misnomer. Augustine also describes how he “collected” what the words that occur in various sentences stood for. That is, he describes a process that others, such as B. Russell, have theorized as inference through abstraction.

There are two ways of getting to know what a word means: one is by a definition in terms of other words, which is called verbal definition, the other is by frequently hearing the word when the object which it denotes is present, which is called *ostensive* definition. It is obvious that ostensive definition is alone possible in the beginning, since verbal definition presupposes a knowledge of the words used in the definitions. You can learn by a verbal definition that a pentagon is a plane figure with five sides, but a child does not learn in this way the meaning of everyday words such as “rain,” “sun,” “dinner,” or “bed.” These are taught by using the appropriate word emphatically while the child is noticing the object concerned. Consequently the meaning that the child comes *to attach to the word* is a product of his personal experience, and varies according to his circumstances and his sensorium. A child who frequently experiences a mild drizzle will attach a different idea to the word “rain” from that formed by a child who has only experienced tropical torrents. (Russell 1948/2009: 10, emphasis added)

As Augustine, Russell here articulates a way of learning “the meaning of everyday words.” «Meaning», in this approach, is referential: A word «means» what it can be identified as denoting, that is, when the child consistently hears the sound /rein/³ while there is “stuff” coming from the sky. Because this stuff or the way it arrives is never the same, the child, so Russell, abstracts from all of these experiences the «meaning» of the sound /rein/, which we transcribe as the word “rain.” Russell also discusses where the different «meanings» that different individuals “attach” to words have their origin: in the differences of the circumstances and sensorium of the *individual*. Thus, a child who only experiences drizzle—typical for London or the Canadian Northwest coast—will “attach” or associate very different «meaning» to the sound /rein/ than the child growing up in Darwin (Australia) or Singapore, who experiences tropical downpours. The philosopher writes of words being “infected with subjectivity” (Russell 1948/2009: 22). In Russell’s definition of language learning, we also note that «meaning» is something that

³ This is a representation of the sound that we tend to hear as “rain” as per the conventions of the International Phonetics Association. These conventions allow speakers of all languages to know and produce the sound independently of the particular sounding rules that other, language-specific transcription rules specify. Thus, Webster’s II New Riverside University Dictionary transcribes a particular sound as /rān/, where the “ā” is to be sounded as the “ay” in pay, which we thereby hear as the word “rain.”

comes to be “attached” to words. These words constitute material bodies, signs as it were, to which something ephemeral is attached or attaches itself. That is, there is something else that comes into play when human beings use language; and this something else is attached to but not visible or directly denoted. As a result, “the common world in which we believe ourselves to live is a construction, partly scientific, partly pre-scientific” (ibid: 12). The whole course of individual development, therefore, constitutes a journey that has “one constant purpose: to eliminate the subjectivity of sensation, and substitute a kind of knowledge which can be the same for all percipients” (ibid: 12). In all of this, the one big mistake Russell makes lies in the opposition he draws “between individual and societal consciousness” (Mikhailov 1976: 131).

Augustine, as Russell, presents the essence of language in this way: “Every word has a meaning. This meaning is correlated with the word. It is the word for which the object stands” (Wittgenstein 1953/1997: 2]). From a pragmatic and post-constructivist perspective, this way of considering language requires deconstruction and revision, for the associated “philosophical concept of meaning has its place in a primitive idea of the way language functions” (ibid: 3). The philosopher continues to say that such an idea is that of a language more primitive of the one that he denotes as “ours.” Wittgenstein extends this argument to the word understanding: “The word ‘understanding,’ the expression ‘to understand a sentence,’ also is not meta-logical, but an expression as *any* other of language. One could say: Why bother with understanding? We have to understand the sentence, that it is for us a sentence” (ibid: 1). From a cultural-historical, dialectical materialist perspective, there is an additional problem with this traditional way of approaching language: it forces a wedge, and creates an unbridgeable gulf, between the world of culture, external to the individual, and the individual. This creates the problem already recognized in the constructivist literature: words, «meanings», «conceptions», or «mental representations» are not shared but can only be taken-as-shared. The very use of these theoretical categories—and Kant’s analysis thereof—leads us into the discourse that is centered on the individual, caught up within its ruminations. But no individual could have an inner dialogue, thought, or consciousness if it were not for language, which is the result of living in a collectivity. Any inner monologue or dialogue is the result and reflection of the outer dialogues that a child has participated in (Vološinov 1930; Vygotskij 2005). The very notion of language implies the societal nature of thought and consciousness, as Vygotsky points out in many of his texts, and, therefore, the impossibility of individuals who create worlds from within themselves and for themselves. Already K. Marx points out that such a way of thinking about thinking and consciousness constitutes a Robinsonade: an impossibility. Cultural-historical scholars reject the idea that the human “individual contains the cause of self-development within himself. This Robinsonade . . . will not be considered further” (Zuckerman 2007: 47–48).⁴ Thus, such issues are due to constructivist epistemology rather than problems of epistemology more broadly. There are ways to language that do not presuppose the split between the individual and societal consciousness, of which language (word) is concrete embodiment, but where each instance of language

⁴ The Robinson Crusoe of the literature is already a cultural-historical product.

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(word) use is a document of culture as a whole. Each individual statement, therefore, can be understood as a concrete instance of the (generally) possible and, therefore, there is unity in the specific and general, concrete and abstract, individual and collective (societal).

As soon as we deepen the analysis of «meaning», we rapidly realize that it leads us to a circularity from which there is no escape: “The meaning of a word is what the explanation of meaning explains” (Wittgenstein 2000: 34). Elsewhere this statement is explicated by saying that if “we want to understand the use of the word ‘meaning,’” we have to look up what is called “‘explain the meaning’” (Wittgenstein 1953/1997: 149). Thus, the mobilization of «meaning» already requires an understanding of «meaning», or, in constructivist terms, it requires the construction of «the meaning of «meaning»». But to know that we have constructed the «meaning» of ««meaning»», we already need to know the «meaning» of «meaning», for otherwise we cannot make a decision that my construction is actually that of ««meaning»» rather than of something else. This attempt to invoke something else that is attached to and belongs to a word, therefore, leads us to an infinite regress. Wittgenstein discusses this problematic in the context of asking for the “meaning of the word ‘thinking’” (ibid: 104). If we watch ourselves during the process of thinking, “it would be as if without knowing how to play chess, I were trying to make out what the word ‘mate’ meant by means of keen observation of the last move in a game of chess” (ibid: 104).

We do not need to draw on «meaning» to explain the experience of thinking: “When I think in language, there are no ‘meanings’ that occur to me in addition to the verbal expression; rather, the language is itself the vehicle of thinking” (Wittgenstein 1953/1997: 107 [§329], my translation). This situation is an analogue to other practices, such as walking: We do not have or require «meanings» in our head when we walk: we simply walk. When we greet our neighbor on a sunny Saturday morning in front of our homes saying “Nice day today, a bit chilly though,” there are no «meanings» floating in our minds or between the neighbor and us in addition to the language that somehow are constructed and accompany. Moreover, the neighbor does not have to engage in an interpretation to construct «meaning» in his/her head or construct what «[personal] meaning» might be in my head when I say “Nice day today, a bit chilly though.”⁵

The problem of «meaning» is exacerbated in translations of scholarly works in the philosophy of language, which makes the construction of a theory valid across languages next to impossible. For example, the translator of Wittgenstein does not consistently translate the German *Bedeutung* into English, by and large rendering it as “meaning,” but also translating it by the term “sense” (e.g., Wittgenstein 1953/1997: 48). But *Sinn* (sense) and *Bedeutung* (reference, signification) are

⁵ This issue has been dealt with extensively in Zen Buddhism. For example, in one koan (riddle), where the decision about the abbot of a future monastery hinged upon the response to the question “This must not be called a pitcher. What do you call it?” while the questioner points to a water pitcher. One of the many reported replies of the head monk was “It cannot be called it a piece of wood.” One of the cooks arrived at the scene and simply kicked the pitcher, spilling all the water. He was named the abbot of the new monastery. One lesson is that naming does not get at the essence of the pitcher. (A deeper, more advanced lesson for Zen practitioners is that even the cook was caught by a fallacy, as his kick has missed the essence—i.e., [negation of the] «meaning»—of the pitcher.)

radically different terms, for there are many sentences for which one can determine their sense but where the reference (signification) is doubtful or does not exist (Frege 1892).

In another situation, the translator uses “sense” to translate the German *Sinn*. The translators of *Being and Time* (Heidegger 1927/1977), whose position is often said to be equivalent to that of the later Wittgenstein, sometimes use “meaning” and sometimes “signification” to render the German *Bedeutung*. Thus, reading an English text on the philosophy of language, we would not know whether the German version used the radically different terms *Bedeutung* or *Sinn*, and, simultaneously, we would not know whether a translator would choose “meaning” or “sense” when the German features the word *Bedeutung*. These variations in the translations are ascribed to the different «meanings» of *Bedeutung*, so that we end up in the situation of pure circularity described above.⁶ The problems become even greater when the uptake of theoretical work in another language is translated back into the source language. Thus, Bakhtin and Vološinov read and actively reacted to the work of the Franco-Swiss linguist F. de Saussure (1916/1995), who uses the French terms *sens* (sense) and *signification* (signification), clearly distinguishing the two. Here, sense is to the word what signified is to the signifier; signification is the *relation* between the two terms of each pair. In their critique of this work, Bakhtin and Vološinov used the Russian “смысл [smysl]” and “значение [značenie]” as equivalents for the terms de Saussure uses (Vološinov 1930). The French translation of their book (Bakhtine [Volochinov] 1977) returns the terms de Saussure used, whereas the English version (Vološinov 1973) vacillates between “sense,” “meaning,” and “signification.” That is, the very distinction de Saussure established has disappeared in the English version of Vološinov. Relative to our STEM community of practice, we might ask how native French-, German-, or Russian-speaking science educators might write in English what they have thought in terms of their native tongues?

Pragmatic approach to data analysis

Consistent with Bakhtin and Vološinov, there is a difference for Wittgenstein between different uses of an expression such as “he comes.” For Bakhtin and Vološinov, the different uses are associated, for example, with different forms of intonations and different forms of social evaluation. Thus, some of the different forms of use are associated with writing the expression alternatively as “He comes.” “He comes?” “He comes!” “*He* comes.” “*He* comes?” “*He* comes!” “*He comes.*” “*He comes?*” or “*He comes!*” Although the two words of the nine phrases are identical, the implications for producing these words with the associated intonations and emphases are different. For example, we might observe the following sequences of turns at talk involving two speakers A and B.

⁶ The very problem is highlighted in the translation of the original title of G. Frege’s essay, where *Bedeutung* is rendered in the English translation that appeared 50 years later as “reference.” If *Bedeutung* is sometimes translated as “signification,” sometimes as “sense,” sometimes as “meaning,” and sometimes as “reference” by appealing that we know what the German author «meant» to say we are already caught up in an infinite regress.

14 On Meaning and Mental Representation

Fragment 1

A: He *comes*?

B: He *goes*!

Fragment 2

A: *He comes*?

B: *He comes*.

Fragment 3

A: He *comes*.

B: He *comes*?

A: He *comes*.

In the analysis of such sequences—which may be observed frequently in science classrooms where students are involved in small-group tasks such as concept mapping or in the one described in the analyses featured in chapters 2–4, and even between teachers and students (e.g., Roth 2009b)—we do not have to worry about any «meaning» as operating somehow behind the words but just focus on what is happening as an irreducible social phenomenon. Thus, in Fragment 1, we have a question|reply turn pair, where the reply part emphatically offers a contrasting verb for describing what the talk is about.⁷ In that situation, the issue was a question as to the nature of the word. We might gloss what happened in this way: A asks something like “Is the verb ‘comes’ the correct one to use?” and B replies by saying something like “No, you need to use ‘goes.’” We observe such a pattern in situations between teachers and students, when the latter offer some response that they are uncertain about, and the teacher, rather than saying “No,” provides the correct term. In Fragment 2, there is also a question|reply sequence; but the issue does not concern the verbs coming or going but the nature of the person in the subject position of the locution “He comes.” The reply part asserts that at issue is the particular person currently being the subject of the statement. It could be another person who is coming, or a question whether this person (e.g., a world renowned expert) is coming to some place. In the third case, there are two full turn pairs. The first pair constitutes an assertion|questioning, where the stress is on the coming; the second turn pair is question|assertive reply turn, whereby the process of coming is at issue and comes to be questioned and asserted as being appropriate. To understand how the conversation unfolds, we need to understand its *inner forces*. To understand the inner forces, we have to look at the interdependence of terms that make turn sequences. Thus, who the “he” is and what “coming” and “going” do *in this situation of interest* can be found out only by looking at language *from within* the particular context. Finally, the three fragments are not just about content, about some person coming or going; the very same language actually produces and maintains the relation between the speakers. It is a soci(et)al relation that subsequently comes to be attributed to the individuals as the higher psychological functions of which Vygotsky speaks in the introductory quotation of this section. Without this relation, there would be no exchange. Relation and verbal exchange presuppose each other.

⁷ I use the Sheffer stroke “|” to construct dialectical notions. The words on the two sides are ways in which the phenomenon denoted by a notion comes to manifest itself. But the phenomenon is not the addition, interaction, or synthesis of the two manifestations. There are two consequences to this. First, the expression encompasses an inner contradiction, because it asserts both mutually exclusive manifestations simultaneously. Second, the expression as a whole is true if and only if at least one of the manifestations is false. Thus, an utterance is not inherently a question. It is a question only when there is a corresponding reply. That is, the question presupposes and is conditioned by what it is not. The expression question|reply makes salient the mutual dependence of question and reply.

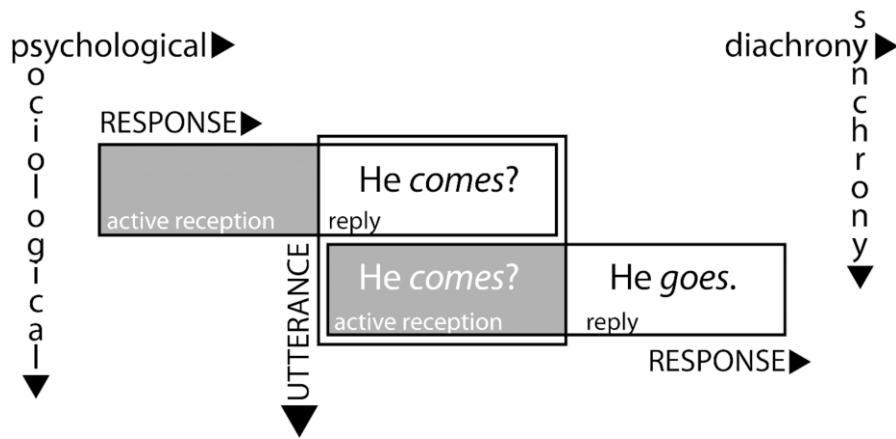


Figure 1.1 This model of conversation has psychological and sociological, diachronic and synchronic dimensions. A phrase is said and heard so that any utterance, such as “He comes?,” belongs to speaker (black) and listener (white); this involves the sociological and synchronic dimensions of talk. The response on the part of the listener includes (is spread over) active reception and reply, and thereby covers psychological and diachronic dimensions.

When we look up in the dictionary, the same dictionary senses will be listed if we enter “he” today or tomorrow; and these dictionary senses will change only slowly over time. (See, for example, the use of etymology and the changes words undergo in their use.) Similarly, the dictionary senses of “to come” are relatively stable. But dictionary sense is actually not at issue, for it is only the material with which the transaction in each of the three fragments is done.⁸ For example, in one instance this might be a conversation about a situation where it is unclear whether a person is coming or going, or where it is unclear who of two persons under consideration is coming. But we hear the conversation very differently when we know it to be between two teenagers talking about a sexually explicit movie they are just watching. When both of these senses are known to exist simultaneously while only one of this is the sanctioned, then we have connotation (e.g., an “in-joke”). Thus, recognizing *what* a person says is equivalent to recognizing *how* a person is speaking, for example, in saying “He comes”: literally, metaphorically, emphatically, jokingly, connotatively, and so on. The *how* of the speaking may be available from other, often very different aspects of a person’s voice or behavior—e.g., a grin, an air quote, a hand gesture, or a body movement. The different dimensions of talk can be understood in terms of the model presented in Figure 1.1.

⁸ The term *transaction* here denotes the fact that in the category question|reply the two manifestations, question and reply, are interdependent. The question is a question only because there is a reply, and the reply is a reply only because there is a question. The nature of a locution cannot be derived from itself but requires the nature of another locution.

In this model, speaker A says “He *comes?*” with a prosodically achieved emphasis on the verb “comes.” But this statement does not belong to A, for B, to be able to reply, has to actively listen to the words. That is, the phrase belongs both to A (who speaks) and B (who listens). When Vološinov or Bakhtin use what has been translated as “utterance,” they name this double belonging of a phrase to speaker and listener. The utterance *simultaneously* belongs to all participants; this is the sociological dimension of conversational talk. Figure 1.1 also shows that the *response* has to moments: active listening and reply (what B actually says). These two moments cannot be understood independent of each other. The response therefore includes parts of B and A, to whom the reply is oriented in turn; it also is spread out in time not only because the words in each part unfold in time but also because active listening and reply occur at different times. The response is diastatic, that is, shifted with respect to itself: it is non-self-identical, being spread out in time and space ([speaker] positions). The figure as a whole represents our unit of analysis, which therefore includes sociological and psychological as well as synchronic and diachronic dimensions. But none of these dimensions can be considered on its own because each implicates all the other.

Up to this point, we do not know what work the statements actually do. From the pragmatic perspective, this requires the context, which determines the “theme” [*tema*] of a statement (Vološinov 1930). The theme would be different for each of the three fragments even if these were to be repeated in identical ways. This is so because, at a minimum, the repetition occurs against a background that no contains the first appearance. The fragments would no longer be the same because they can be recognized as repetitions and therefore raise new questions—e.g., why speakers repeated what they had said. The theme is the relation between the statement (word, phrase) and the historical situation, which, because it is never repeatable and “once-occurrent,” leads to the fact that the theme associated with, or function of, each statement of “he comes” changes. This change is both local, here *within* each fragment, and global, the recurrence of the same fragment in historical time. Thus, even if the same two people were to have the same exchange at another point in time, the theme would be different. This is the case although the dictionary senses of the words “he” and “comes” will not have changed—unless the distance in historical time becomes very large. The theme, therefore, is the continually changing function of expressions always tied to the immediate contexts of word use. This context *never* is the same, as every “event of Being” is only “once-occurrent” (Bakhtin 1993: 2).

Words are used to manage events (situations), which in turn assist in managing the use of words. And events are experienced in terms of a practical understanding of the (life-) world, which is given to us prior to any “conception”—an infant does not have to have any conception of crawling or pointing to crawl and point. Vološinov’s formulation of the theme, therefore, returns us to the pragmatist position, which suggests that there is “no learnable common core of consistent behavior, no shared grammar or rules, no portable interpreting machine to grind out the meaning of an arbitrary utterance” (Davidson 1986: 445). Any boundary between knowing and language and knowing one’s way around the world more generally is thereby erased. This is the very point that an analysis of the nature of commonsense understanding of the role of words therein has shown. Thus,

“word-things are not provided with significations/meanings” (Heidegger 1927/1977: 161); instead, “words accrue to significations/meanings” (ibid: 161). Thus, it is not merely the use rather than some «meaning» that exhibits the nature of language, but linguistics expressions “must mesh with *my own life*” (Wittgenstein 1977: 66). As a consequence, there is “no such thing as a language, not if a language is anything like what many philosophers and linguists have supposed” (Davidson 1986: 446). The philosopher continues to say that we must give up the idea of a clearly defined shared structure that language-users acquire and then apply to cases. Instead, anything that is done with language is a situated coping with the current conditions, continually adapted to the purposes and needs at hand.

From a psychological perspective, we understand others based on the presupposition that what they say is rational, purposeful, planned, and coherent. In and with their saying, they provide the resources for understanding a locution literally, metaphorically, emphatically, jokingly, connotatively, and so on. That is, the rule for understanding unfolding talk is provided in the manner of talking itself: the rule does not exist behind, underneath, or in some other place. Thus, for a recipient to hear a statement as a double entendre, the resources for such hearing have to be available in the here and now of the situation. “*Shared agreement*’ [then] refers to various social methods for accomplishing the member’s recognition that something was said-according-to-a-rule and not the demonstrable matching of substantive matters” (Garfinkel 1967: 30, original emphasis). As a result, “*the appropriate image of a common understanding*” no longer is that of “*a common intersection of overlapping sets*” (ibid: 30). A better image is that of an operation, where there is no longer a distinction between the word and its meaning. The locution itself provides us with the rule for how to hear it. Thus, in Fragment 2, for example, the exchange “*He comes?*” “*He comes.*” shows that the first locution can be heard (a) as *a question* and (b) as a question about the nature of the person: it is *he* rather than someone else. A more definite hearing may depend on the next turn not reproduced here, for the second turn itself is a first turn in a turn pair. That is, whereas the statement “*He comes.*” completes a turn pair, thereby contributing to the closure of its nature (e.g., as a question|reply pair), its own nature depends on the turn that follows. Therefore, saying here that it is a “reply” actually presupposes our hearing of the turn that follows but is not reproduced here.

Readers may ask, “How can people communicate without a ‘shared understanding’?” From the pragmatic perspective, real-time interlocutors and authors/readers in everyday exchanges pragmatically resolve issues pertaining to the words and other expressive signs they use. After discussing the example of someone being sent to buy “five red apples,” Wittgenstein elaborates on the question of the meaning of the word “five”: “What is the meaning of the word ‘five’? No such thing was in question here, only how the word five was used” (Wittgenstein 1953/1997: 3). We know this to be the case, for nobody in North America will have trouble appropriately reading a roadside sign “firewood 4 sale.” No resident in the community will wonder about “the meaning of ‘4.’” Nor would they have to wonder about the «meaning» of “Xmas” (as in “Xmas sale”), “Xing” (at a pedestrian crossing), and “X-ing” (as in “X-ing” a day in the calendar) and give the difference between the Xs that appear in each of these three contexts. Ethnomethodology

generally and conversation analysis specifically specialize in describing and explicating the work of *how* people communicate and get things done without seeking recourse to «meanings», «(taken-as-) shared understandings», or «negotiations». The “theme,” too, though making use of the stable feature of word-sense, precisely because it is ever changing, is subject to the local, indexical, and endogenous practices that produce the orderliness of soci(et)al events. Precisely because it is ever changing, there cannot be general rules for deriving local use of specific words and language. This is so especially because new communicative forms may spontaneously emerge that have no prior history of being «constructed» or «negotiated» and «having been agreed upon». Even though new words spring up suddenly, they may be, and usually are, immediately understood.⁹ As the example of “He comes” shows, what is being done across situations using the same words will differ; and the *how* of the doing is managed in ways appropriate to and taking into account all local contingencies. In fact, the particular approach to the analysis employed in the example of the different versions of “He comes” and the featured excerpt—i.e., a version of conversation analysis—is included and integral part of ethnomethodology (Garfinkel 1988). The collective conversational management practices cannot be reduced to the individuals but always already are something that constitutes a *joint* accomplishment, which, inherently, cannot be reduced to any one of the individuals present. This *joint* accomplishment is *inherently* social and cannot be reduced to individual accomplishments.

There is one field where the pragmatic approach is implemented in a radical way: ethnomethodology. In this approach, which concerns the way in which members to a setting produce and exhibit for one another accountable social structure, three main assumptions made leading to the dropping of metaphysical positions: (a) “that . . . we must at the outset know what the substantive common understandings consist of” (Garfinkel 1967: 28); (b) the “accompanying theory of signs, according to which a ‘sign’ and ‘referent’ are respectively properties of something said and something talked about” (ibid: 28); and (c) “the possibility that an invoked shared agreement on substantive matters explains usage” (ibid: 28). Thus, a point also made by Davidson and Rorty, shared meanings in the psychological (constructivist) sense are not required for people to engage in *sympractical*¹⁰ activities and to collaborate. If the notions «shared understanding» and «shared meaning» are dropped then *what* the parties to a conversation talk about cannot be distinguished from *how* the parties are speaking. An explanation of

⁹ I know this to be the case, because my wife Sylvie and I often make up new words and yet immediately understand them. Thus, shortly after the beta version of Google had become available, I used the verb “to google” prior to ever having heard it. Sylvie immediately knew—without having to “interpret” my words or “constructing meaning” thereof—that I suggested looking up something on the Internet using the Google browser.

¹⁰ The adjective *sympractical* refers to the fact that activities require *joint* action. However, joint action here is understood from a *sociological* perspective that does not reduce *social* phenomena to the individuals involved. Thus, although A and B participate in the three fragments analyzed above, the unit of a turn pair such as question|reply cannot be reduced to one or the other person. There is not just an interaction between two independent utterances that A and B produce. Rather, there is a *transaction* where the *whole* determines the nature of each part; and this whole is a collective consisting of A and B. Thus, each part, question or reply, is a function of A and B simultaneously. The part cannot be reduced to A or B. (See also [Figure 1.1.](#))

what the parties are talking about then consists entirely of describing *how* the parties have been speaking. This, therefore, says the same about talk that Wittgenstein says about thought in terms of verbal thinking. What we think can be described entirely in terms of the words used; it is unnecessary and deceiving to invoke «meanings» that somehow are behind or underneath the speaking and thinking at issue. We therefore abandon the distinction between words and «meaning», that is, we abandon distinguishing “*what* was said and *what* was talked about” (ibid: 29). Instead, we make another, more appropriate distinction “between a language-community member’s recognition that a person is saying something, i.e., that he was *speaking*, on the one hand, and *how* he was speaking on the other” (ibid: 29).

For a re/construction of «meaning» and «mental representation»

In the STEM research literature we frequently find encouragements for students to “refine their meanings” so that these better correspond to the “standard meanings” of science. In this book, I suggest that such recommendations should apply to the work of STEM educators as well. If we do not re/construct our fundamental concept and category words after bracketing their everyday use but use them in the differing, even antithetical ways that have historically emerged, we end up with a discourse that is only half scientific (Bourdieu 1992). The purpose of this book is to make a case for the need to bracket the fundamental concepts and categories that we use in the STEM literature and to reconstruct these in a truly scientific approach. The case is argued by means of an analysis of the uses of «meaning» and «mental representation» and by an articulation of a pragmatic approach that makes the problematic concept unnecessary. Because each “word, like the sun in a drop of water, *fully* reflects the processes and tendencies in the development of a science” (Vygotsky 1927/1997: 288), the categorical re/construction of «meaning» and «mental representation» likely will affect STEM education as a whole. Moreover, because the pragmatic approach does not require the postulation of a metaphysical domain in which «meaning» exists but solely focuses on how participants use language and other sign forms to produce order and orderly conduct, many of the traditional dichotomies fall to the wayside. These include the dichotomous splits between body and mind, personal and shared knowledge and application, knowing-that and knowing-how, and knowing a language and knowing one’s way around the world.

The intent here is not to critique the uses of «meaning», «mental representation», «mis/conception» and the likes, especially when these uses appear to be contradictory within the same text. Throughout this book I present analyses that show that the way in which «meaning» and associated terms tend to be used presupposes a particular epistemology; also throughout this book I present alternative analyses of transcripts that sketch an approach where the classical use of «meaning» is dropped from consideration. Instead, I propose a different use, where «meaning» and «mental representation» (or, rather, «social representation») are families of ways of speaking that can stand in for each other. Such an approach, as intimated, also is consistent with the cultural-historical approach, according to which any higher psychological function *is* a societal relation.

Categorical reconstructions—e.g., of «meaning»—will certainly require considerable individual (book-length) and collective efforts, where critique of particular uses may indeed have an important role. A considerable part of this interrogation consists in the archeology of the field and its discourse. This analysis has two tasks with respect to the fundamental epistemological figures (rational elements) that are used: “to determine the manner in which they are arranged in the *episteme* in which they have their roots; and to show, also, in what respect their configuration is radically different from that of the sciences in the strict sense” (Foucault 1966: 377). It is precisely in the negative that our theoretical “language emerges in all its nudity, yet at the same time eludes all signification as if it were a vast and empty despotic system” (ibid: 386). Thus, for example, when a text uses descriptions such as “meaningful use of technology as a research tool” or “meaningfully deploying the technology as a teaching and learning implement” (JRST 2011: 65), we might legitimately ask about the nature of the work done by the term «meaning». We do so by asking a question about the negative: What is a meaningless use of technology? Thus, we might ask the question in an analogical situation: “What is a «meaningful» ‘use of a hammer?’” or “What is the «meaningless» ‘use of a hammer?’”—if we are interested in an authentic situation where someone intends to drive a nail into a wall? What do we say and hear when using an expression such as “«meaningful» inclusion,” and what might be a “«meaningless» inclusion” on the opposite end? If a “debate” is modified by the adjective «meaningful», we might legitimately seek clarification by looking for concrete cases in our databases where a debate is «meaningless», for whom, how participants make the problem available to each other as social order. It might turn out that the very fact that people debate an issue should be taken as the point of entry into the analysis, and those who participate in the debate would not do so if there were no pertinence to what they are doing. So what might be a real, concrete debate between people that is «meaningless»? It is through the madness of the negative that the tenuousness of concepts shines through the cracks of a system that wants to be infallible. If we do not engage in such work of constructing our categories by bracketing their common and scientific uses, then, as Bourdieu suggests, we literally do not know what we are doing. But we can do better than that—if we begin by bracketing and reconstructing the fundamental concepts and categories of our field. In the chapters that follow, I do precisely that. I bracket the use of «meaning» for the purpose of reconstructing how (and when) this term and all associated terms might suitably be used.