What you should know to survive in knowledge societies. On a semiotic understanding of 'knowledge'

Michael H.G. Hoffmann, Georgia Institute of Technology - Main Campus
Wolff-Michael Roth, Wolff-Michael Roth

Available at: https://works.bepress.com/michael_hoffmann/15/
What you should know to survive in knowledge societies: On a semiotic understanding of ‘knowledge’

MICHAEL H. G. HOFFMANN AND WOLFF-MICHAEL ROTH

Abstract

Different situations — like school and workplace — demand different forms of knowledge. Even more important, in particular for lifelong learning, are forms of knowledge we need for managing movements between those situations. To develop a better understanding of how to ‘navigate’ knowledge boundaries, this paper analyzes, firstly, interviews with scientists interpreting familiar and unfamiliar graphs. Our goal is to identify those forms of knowledge that should receive special attention in education. Secondly, the article elaborates — based on Peirce’s semiotics — an epistemologically reflected semiotic model to describe the role and conditions of knowledge necessary for crossing knowledge boundaries.

1. Introduction

1.1. The problem: Lifelong learning

Lifelong learning is a sine qua non for successful transition into knowledge-based economies. Thus, the Commission of European Communities holds that ‘lifelong learning is no longer just one aspect of education and training; it must become the guiding principle for provision and participation across the full continuum of learning contexts’ (Commission of the European Communities 2000). Knowledge-based economies will change much more rapidly than traditional economies because of the exponential increase in total knowledge; individuals will be required to continuously update their knowledge to keep pace. An International Labor Office report suggests that if knowing and learning are not renewed, adaptation to new environments by individuals, and therefore by communities or nations, will be reduced and even become impossible (International Labor Organization 2000). Arguably the most critical...
points in any lifelong learning path occur when learners leave formal education to enter the world of work. It is at this juncture that many people experience numerous gaps between their 'book knowledge' and what is required in the 'real world.' As people must adapt to changes in the workplace, they often return and attend learning institutions to gain the skills that they are expected to bring back to their old and new jobs. How does their existing job experience mediate learning in the formal education setting? How does anything they learn in the formal setting translate into job-related knowledge? Little is known about how individuals navigate the boundaries between their 'book' and 'real-world' knowledge and between 'real-world' and book knowledge. Knowing how people navigate this boundary is of tremendous importance to all nations that are embracing a knowledge-based economy. 'Updating' and 'retooling' are increasingly required to maintain skills at marketable levels.

Understanding how people manage to move back and forth across knowledge boundaries requires different empirical studies and, maybe, different theoretical approaches depending on the specific questions that might be formulated within this general research context. Here we use interviews with scientists interpreting familiar and unfamiliar graphs as paradigmatic examples of how people manage crossing boundaries. They are paradigmatic because interpreting graphs is a special case of interpretation in general, and interpretation again is the first thing we have to do when we are confronted with new situations and problems. The issue of interpretation directly takes us to Peirce's semiotics or, more precisely, to the 'interpretant' in his triadic sign relation. Here we propose a way of using semiotics to theorize and analyze knowledge during boundary crossing experiences. The questions we explicitly address in this article include: 'What forms of knowledge do people use when they are confronted with changing situations and with new tasks going beyond of what they have learnt explicitly in a certain context?' and 'in which way do different forms of knowledge work together when people have to solve unfamiliar tasks?'

1.2. Toward a (new) solution

Sometimes big old problems look surprisingly fresh if one looks at them through new lenses. This happened to us, a philosopher doing semiotics and a cognitive scientist, in the course of a six-month collaborative effort to understand the nature of knowledge as people move across the boundaries between formal education and workplace — as demanded for lifelong learning within the modern knowledge societies. After having worked in our own lives at several boundaries — in particular between philosophy, physics, mathematics, science education, and semiotics — we quickly realized that we needed to know what knowledge is if we wanted to answer the question about the forms of knowledge that are relevant during the navigation of the boundaries between very different life situations, and are necessary particularly for interpreting unfamiliar situations. For us, the problem of crossing knowledge boundaries was a starting point. The main focus of this paper, however, is a philosophical one: What is knowledge, and which forms of knowledge should we distinguish with regard to the possibility of lifelong learning.

In this paper, we bring our very different backgrounds together, empirical-ethnographic research and epistemological-semiotic reflection, to offer a different solution to the knowledge problem. People face real problems when they try to understand unfamiliar situations and have to learn coping with them. Our ethnographic approach allows us to analyze such problems people experience in concrete situations. The role of epistemology and semiotics is to provide theoretical means that can be used to describe (model) the observed events. There are of course theoretical frameworks other than epistemology and semiotics that could be used such as information processing. Confronted with the problem of knowledge, however, one immediately faces epistemology, one of the oldest branches of philosophy, which primarily is concerned with both the questions how knowledge is possible and how it can be justified. Semiotics, on the other hand, is interesting since for all kinds of learning processes signs and representations are essential: representations are fundamental for communication, and they are essential for accessing all sorts of abstract objects, ranging from mathematical, physical, biological entities that are not visible to ideas like freedom, justice, and responsibility.

In this article, we take the semiotic approach further. We start, in the first part, by sketching a semiotic model to describe the role and conditions of knowledge in a most general way. Our thesis is, on the one hand, that Peirce's triadic sign relation — where a sign mediates between an object and what he calls an 'interpretant' — can be a model for a triadic relation in which a network of knowledge forms mediates the relation between knowledge and what is known. On the other hand, we show how Peirce's concept of diagrammatic reasoning can be used to describe learning as a process in which those mediating knowledge forms can be developed by representing them in 'diagrams,' and by experimenting with those diagrams.

In the second part of this article — which is based on an ethnographic research project in which scientists were asked to interpret graphs that were partly from their own field of competence and partly from other fields — we distinguish relevant knowledge forms to come to grips with
the idea of a knowledge-mediating network of knowledge forms. We focus on direct comparisons between the ‘in-field’ and ‘out-of-field’ situations, because being asked to interpret unfamiliar graphs leads to a kind of ‘breakdown’ of the usual habits we perform in interpretation tasks and motivates a much more explicit reflection on the conditions that must be fulfilled for any interpretation task. By going back and forth between analyzing both situations — familiar and unfamiliar graphs — we identify (a) those forms of knowledge which are always relevant but ‘hidden’ with the in-field tasks and (b) those capacities and skills that are additionally provoked while working on out-of-field tasks. Particularly, we discuss different forms of practical knowledge that are important for coping with problems in a most general way and analyze the role of what we call ‘intersubjective, shared knowledge.’ Although this knowledge form seems to be essential as a precondition for communication and cooperation — and thus for all forms of social learning — some may find it hard to accept that knowledge can be ‘shared.’ We propose a recent empirical method — the analysis of pitch in speech — that can be used to qualify the grade of harmony, or consonance in the word’s very meaning, between speakers by direct comparison of pitches. The thesis is that this grade of harmony or disharmony is unconsciously known by all participants in a communication, forming thus a very basic form of knowledge that is essential for the 'chemistry' between people, and thus for opening up the very possibility of communication and interaction.

In the third and final part of this paper we formulate a general definition of knowledge that can encompass all these forms of knowledge we distinguish in the second part, and that fits with our semiotic considerations elaborated in the first part.

2. Semiotics and the possibility of knowledge

Our goal is to develop a semiotic model of knowledge suitable for describing the performance of people as they cross knowledge boundaries. To show the relevance of this new approach, we begin in this section with a critique of the classic concept of knowledge as it is known since Plato. Then, we articulate Peirce’s concept of the sign and elaborate its epistemological significance.

2.1. The classic concept of knowledge

The classic definition of knowledge says that a person X ‘knows’ the proposition p if and only if, first, X believes that p is true, second, p is indeed true and, third, X can formulate reasons, or can explain, why p is true. From our perspective, the two problematic points lie in the second condition and in the fact that knowledge is limited to what can be expressed in the form of propositions. Let us start with this point.

Restricting knowledge on what can be represented in form of propositions might be sufficient for philosophical purposes, but it is insufficient if we want to describe which forms of knowledge are necessary for explaining the possibility of learning.

1. Learning involves more than only knowledge that can be represented in the form of propositions or sentences ("knowing that"). More important is a form of knowledge called "knowing how" (Ryle 1949) or "strategic knowledge" (Hintikka 1997). To win a chess player, we must not only know the game's well-known 'definitor' rules, but also some 'strategic' rules, and the same is true for solving problems and all kinds of 'meta-knowledge' (Bateson 1972). Already Plato distinguished 'practical' and 'theoretical' knowledge (praktikē versus gnōstikē epistēmē) and defined the former as 'grown together with practices,' while the latter is abstracted from all practice (Plato Pol., 258d, e). "Knowledge" in the sense of practical knowledge does not need to be represented propositionally but can exist in forms glossed by the notions 'skill' and 'competence.'

2. Many empirical studies within the so-called 'situated cognition' and 'social practice' paradigms have shown that human knowing varies considerably with context, so that knowledge should be conceived of as 'situated' (details below). In a similar way, 'social epistemology' in philosophy emphasizes the interpersonal and institutional contexts that shape and inform individual knowledge (Goldman 2001). The observation that contexts and situations are at least partly relevant for the possibility and specific formations of knowledge should be a sufficient reason to enlarge the traditional understanding of knowledge.

3. While social epistemology still focuses on individuals as epistemic agents, a most recent development in philosophy about 'collective epistemic agency' tries to formulate a clearer understanding of what it could mean that groups know something different than the sum of its members' knowledge (Tollesen 2004). In activity theory again — firstly developed by the Russian psychologist Lev S. Vygotsky in the beginning of the twentieth century — learning has been conceptualized as a process of 'internalizing' of what is given before at a social or cultural level (Bruner 1983, 1990; Vygotsky 1977; Wertsch and Stone 1985). Symbolic interactionists reformulated this idea by
suggesting that knowledge emerges in social interaction. With regard to this, in mathematics education the concept of ‘knowledge taken-to-be-shared’ has been developed. Such knowledge is supposed to emerge during processes of negotiating the meaning of mathematical concepts in classroom communication. ‘A meaning taken-to-be-shared is not a cognitive element; it exists at the level of interaction’ (Voigt 1998: 203; cf. Blumer 1969). The question is, however, how to understand exactly the idea that knowledge is intersubjectively present. But it is clear that the individualistic approach of classical epistemology cannot be an adequate tool for this question.

These considerations imply that we need a more general concept of ‘knowledge’ than the traditional one. The analysis following in the second part of this paper will give us some hints which forms of knowledge are necessary for navigating knowledge boundaries.

The second critical point of the classic concept of knowledge concerns the claim that a proposition has to be true to be known. This condition is necessary for clearly demarcating knowledge and belief. Having a belief concerning \( p \) means that it is an open question whether \( p \) is indeed true, whereas having knowledge about \( p \) means that \( p \) must be true. The problem is that this definition can never be applied to identify certain pieces of knowledge as knowledge in contrast to belief. Such an application would presuppose to justify the truth of a proposition \( p \), which has knowledge about \( p \) as a prerequisite. From an epistemological point of view — that is, with regard to the problem of justification — it is without question that a ‘final justification’ of any proposition is never possible (e.g. Haack 1993; Hoffmann 2005). This implies that there cannot be a distinction between knowledge and belief, which therefore requires a modification of the knowledge concept.

2.2. The semiotic approach

From a semiotic point of view, such a modification might proceed as follows. What is ‘hidden’ in the condition of \( p \)’s truth is the fact that knowledge is about something: in the case of propositional knowledge, we always know of an ‘object.’ Thus, the essential question is how can we know of an object? In contrast to other semiotic approaches, the main advantage of Charles Sanders Peirce’s approach is that it addresses exactly this question.

In ‘Questions concerning certain faculties claimed for man,’ for instance, Peirce (1868) argues that cognition never immediately refers to objects, and that even ‘our whole knowledge of the internal world is derived from the observation of external facts’ since emotions and feelings are motivated and triggered by something outside ourselves (CP 5.213 ff.). In this way, mental states are interpretations of objects whereby the object of a thought might also be a previous thought, that is, something mental again. But the point is: to know thinking, thoughts must be represented in something external:

(We) have seen that only by external facts can thought be known at all. The only thought, then, which can possibly be cognized is thought in signs. But thought which cannot be cognized does not exist. All thought, therefore, must necessarily be in signs. (CP 5.251)

To grasp what is meant by this argument, we have to develop at first an understanding of the term ‘sign.’ Peirce’s most famous definition is the following:

A sign, or representamen, is something which stands to somebody for something in some respect or capacity. It addresses somebody, that is, creates in the mind of that person an equivalent sign, or perhaps a more developed sign. That sign which it creates I call the interpretant of the first sign. The sign stands for something, its object. It stands for that object, not in all respects, but in reference to a sort of Idea, which I have sometimes called the ground of the representamen. (CP 2.228)

![Diagram of semiotic relations](image)

Figure 1. Peirce’s triadic sign relation

Essential for Peirce’s semiotics is the idea that a sign is embedded in a ‘triadic relation’ together with an object and an interpretant (e.g. CP 8.343; cf. Figure 1). With regard to that, his reference at the ‘ground’ in this quote might be problematic, because if this ground were an independent element, we would have a quaternary rather than a triadic relation. Instead of assuming that ‘a sign must be conceived of as a whole unit that
has three tails, or places for subjects that are related' (Hausman 1993: 72), namely object, interpretant, and ground, we suggest to conceive it just the other way around: any sign is embedded in a triadic relation as described in Figure 1 (and as supported by many other Peircian statements), but this relation again may be embedded in different 'grounds.' Here we take 'ground' like in 'background,' that is, as a certain horizon that specifies a certain triadic relation due to the fact that (a) any object can be represented by many different signs and (b) any sign can have many different interpretants - both according to different 'respects' of the object to be represented.

With regard to our epistemological question concerning the possibility of knowledge, the most interesting part of Peirce's triadic model is what he called the 'interpretant.' In contrast to limiting the interpretant to what is created as a further sign 'in the mind' of a person as in the quote above, Peirce defined the interpretant in later writings more generally as 'the proper significant outcome of a sign' and as its 'effect' (CP 5.473, 5.475). Thus, the interpretant can be (a) a reaction to a sign or its effect in acting, feeling, and thinking or (b) its meaning. According to Peirce's later differentiation of possible interpretants (cf. Hoffmann 2005: 47), this meaning again can be located in either an individual or a collective. Thus, the interpretant should not be confused with an interpreter. The interpretant might be a spontaneous reaction within a person's mind or it might be the normal reaction 'produced on the mind by the Sign after sufficient development of thought' (CP 8.343), but it also can be any arbitrarily created meaning within a certain group of persons or the shared standard reaction to a certain sign within a group which may be defined by certain societal or cultural characteristics. Peirce also coins the concept of a 'cominterpretant' to signify an interpretant as it might evolve, perhaps only momentarily, as shared meaning between dialogue partners in concrete interaction (cf. Stenz-Ludlow in press). What might be called the 'objective meaning' of a sign is, for Peirce, the 'final logical interpretant,' that is, the meaning that ideally (not actually, because it is an infinite process) emerges in the scientific community in the long run.

2.3. Semiotic epistemology

The main idea of our semiotic approach is applying this notion of an interpretant to the question how knowledge of an object is possible. According to this approach, any piece of knowledge can be grasped as an interpretant of a sign representing an object as described in Figure 1. In this way, knowledge is always mediated by signs or, as Peirce says in the quotes above, 'our whole knowledge of the internal world is derived from the observation of external facts' and 'All thought ... must necessarily be in signs' (CP 5.213 ff.). We interpret this to mean that everything we know as a result of interpretation - may it be an interpretation of our internal states or of the external world - we know in the form of interpretants of signs. This implies that (a) the greatest part of our knowledge has been generated in a form that can be described by the triadic sign relation represented in Figure 1 and (b) signs mediate the entirety of this knowledge.

How can this 'mediating' function of signs be understood more precisely? On the one hand, the mediating function is evident when we consider the fundamental role of external representations in learning processes - this has been done elsewhere drawing on Peirce's concept of 'diagrammatic reasoning' (Hoffmann 2003, 2004; Stjernfelt 2000). A 'diagram' here is formally defined as a representation of relations generated by means of certain representational systems (e.g. a language, an axiomatic system, or another sign system like styles in art). According to this definition, also speaking and formulating sentences can be described as constructing diagrams: by constructing diagrams, ephemeral and fleeting thoughts are concretized in a fixed and visible format thereby enabling thinking individuals to control their thought. Most importantly, by experimenting with diagrams our own thinking becomes an object of analysis. By experimenting with diagrams, we can develop implications of our thought, we can see limitations of our thinking, and we can improve the used representational system either by introducing new elements, or by restructuring the whole system - which has been discussed as generalization of representational systems (Hoffmann 2005). Therefore, 'All our thinking is performed upon signs of some kind or other, either imagined or actually perceived. Mentally experimenting upon a diagram or other scheme constitutes the best thinking, especially on mathematical subjects, and it facilitates the thought to have it before one's eyes' (NEM 1: 122).

Thus, for any 'concept' or mental state 'external signs answer every purpose, and there is no need at all of considering what passes in one's mind' (NEM 1: 122). Especially for learning by communication, thoughts must be made visible in representations. In this way, the essential role of signs as 'mediators' between knowledge and what can be known is evident.

On the other hand, however, it might sound strange to claim that all knowledge is sign-mediated. In empirical studies it could indeed be shown that scientists asked to interpret graphs from their own field of competence seem to have immediate access to the reality as described by those graphs. The epistemological situation seems really to be turned around here: although being confronted by signs, people in a variety of situations...
act as if there were no signs at all but directly what is represented by those signs (Roth 2003). A comparison of scientists interpreting in-field and out-of-field graphs revealed the following. While in the case of interpreting unfamiliar graphs the graph itself is the object of investigation, in the case of familiar graphs, "when they know a graph very well ... scientists conflate them with the phenomenon itself" (Roth and Bowen 2003: 468). Familiar graphs are "transparent" to us, so to speak, "allowing direct access to the phenomena the graph is said to be about" (Roth and Bowen 2003: 470).

From a semiotic perspective, this can be interpreted as follows. While in the case of familiar graphs these signs are a means of getting access to reality, they are the objects of investigation in the case of unfamiliar graphs. Such situations can be thought of in terms of 'complementarity' or 'dialectic of means and objects' (Otte 1997: 360). For learning processes, it seems indeed to be most important to 'switch' between both possibilities. By means of this complementarity or dialectic, interpreting signs can be described as a reflexive process in which considerations regarding the sign itself and the signified 'content' are developed in mutual dependence from one another: in the form of a 'reflexive and constitutive process in which particular readings of signs and potential content are mutually adjusted until they are consistent' (Roth and Bowen 2003: 439; see also Roth and Bowen 1999). Elsewhere, we elaborate this idea by developing the concept of a 'dialectic system' to describe this reflexive process more precisely (Hoffmann and Roth 2004).

As we show below, however, one of the most interesting further observations is that also in situations where scientists seem to have direct access to the reality as described by a graph, they tacitly use the same strategies and concepts that became explicit with the unfamiliar graphs. This observation forces us to enlarge Peirce's triadic sign relation. Even if in the case of 'in-field' graph interpretations the graph itself seems to be conflated with its object, the knowledge expressed by scientists in this situation is mediated by the graph in front of them from an analytic point of view. Thus, for describing this situation, our Figure 1 above is sufficient. However, when the sign itself is the object of investigation — as in the case of out-of-field interpretations — our empirical results should be interpreted by saying that the graph becomes an object of a different sign relation which for itself is mediated by what could be called — within the semiotic model — a further sign or by a form of implicit knowledge (or more precisely: of collateral knowledge as defined below). Since it is clear with the unfamiliar graphs that something is represented by the graph — even if the very problem is just: what exactly? — we can say that the sign in the original triadic sign relation transforms into an object that itself is accessible only by means of what we call a network of different knowledge forms (Figure 2).

On the one hand, it is well known that any interpretation of whatever is mediated by prior knowledge (Ausubel et al. 1978). For example, an ecologist who knows about animal populations approaches the interpretation of a population graph very differently than a physicist: the former may draw on her familiarity with cod stocks or wolf-moose interactions to talk about the graph whereas the latter may struggle saying anything at all or talk about its mathematical aspects (Roth 2003). Thus, it is different background knowledge that leads to different interpretants of a sign. To distinguish those forms of knowledge more precisely is the proper goal of this paper. On the other hand, however, we already identified the interpretant in Peirce's triadic sign relation with knowledge as generated by interpretation. Thus, in our Figure 2 'knowledge' simultaneously appears in two positions, once as the result of interpretation, once as its condition, implying that the development of knowledge through interpretation is enveloped by existing knowledge (Ricoeur 1991). It seems indeed essential to distinguish between knowledge that is generated by interpretation and forms of knowledge that constitute a condition of knowledge generation.

From an epistemological point of view, we generalize this consideration by formulating the hypothesis that the objects of our (internal and external) world are accessible only mediated by knowledge (Figure 3). This is another formulation of Kant's idea that the possibility of knowledge and experience depends on 'a priori' given concepts and forms of perception, or the idea that any observation is 'theory-laden' (Carriere 1994). More interesting to us is that knowledge generation can be described as a process in which the mediating knowledge for itself can become an object of further consideration when it is represented in signs and diagrams. Essentially, this is the idea underlying the concept of diagrammatic reasoning. The development of knowledge is possible by
representing what we already know in diagrams, and by experimenting with these diagrams.

Compared with the classic concept of knowledge, an essential advantage of our semiotic approach is that the problem of knowledge justification can be treated in an epistemologically more adequate manner. The interpretant provides a conceptual means to describe knowledge as ranging from purely subjective interpretations up to what can be assumed as the best justified theories of scientific communities at a certain point in history — without being threatened by the never-ending problems of justifying truth. The only remaining problem of justification concerns the justification of interpretants. Thanks to the fact, however, that interpretants in our semiotic framework are necessarily relative, that is, depend on the respective 'ground' or semiotic situation, background knowledge and so forth, the problem of justification is not a problem of the triadic sign relation. Rather, it is a problem that a knowledge community has to practically resolve in its ongoing interpretive sign processes (semioses).

3. Knowledge forms

To gain a broad overview of forms of knowledge relevant for interpreting new situations (cf. Figure 12), we begin with an example of a physicist asked to interpret (a) an unfamiliar graph from ecology and (b) a more familiar graph from physics. We analyze and compare the interpretive processes with respect to both graphs by asking (a) what forms of knowledge can be identified and (b) what are the specific differences between interpreting familiar and unfamiliar graphs. The two graphs were selected such as to be structurally (mathematically) equivalent.

3.1. Interpreting an unfamiliar graph

The interview began by presenting to the physicist 'L' an unfamiliar graph representing the different distribution of three types of plants in an area of southern Texas (Figure 4). After looking at the graph and reading the text beside it, ending with 'What implications can you draw from this graph?' our physicist 'L' starts as follows:

![Distribution graph ecology](image)

L: So you want me to answer that.
D: um yeah just start um analyzing it as you would
L: Yeah, well, first thing you do when you look at a graph like this you try to make sure you understand the — the axes. Important in a graph is always to have well labeled axes this is what I tell my students; so somebody gives a talk and presents a graph that is not labeled properly it is very insulting.

![Interpreting an ecology graph](image)
From the present perspective, there are three interesting points in this brief episode. First, L starts with a reflection on what you do when you look at a graph like this. He steps back, so to speak, reflecting generally on methods and strategies. What becomes visible is a kind of 'practical knowledge,' knowledge about good strategies. He knows what to do when confronted with a graph: looking at the axes. Second, he combines this reflection on methods with a reflection on his role as a teacher: 'this is what I tell my students.' He thereby highlights that this kind of practical knowledge has to be learned by students. But he also intimates being someone who teaches his students such practical knowledge. Thus, he presents himself in this situation as a certain kind of person. Social semiotics suggests that this kind of positioning oneself in a certain way is very important for influencing how we become interpreted by others and thus for directing the course of an interaction (Morgan, in press). By participating in social situations, we learn to regulate social interactions in this way, mostly without awareness of doing so. The possibility, however, of positioning ourselves in such a way depends on a set of very different forms of knowledge. We again need practical knowledge to do it in an adequate manner, which means, first of all, that it should not be too obvious. If our dialogue partner recognizes that we try to manipulate the communication, the effect likely would be the opposite. But we also need (a) knowledge about ourselves, a certain self-assessment or good estimate of our abilities, and their limits and (b) knowledge of the situation in which we are currently involved. This includes (a) knowledge of the coparticipants in the situation and the implicit hierarchies that distinguish the coparticipants and (b) advance estimates of possible effects of our actions. Most of this happens completely beyond our consciousness (Damasio 1999).

Third, there is a reference to his own experience what happens when 'somebody gives a talk and presents a graph that is not labeled properly.' Characterizing this as 'very insulting' can be interpreted as giving an argument that is based on a strong emotion. He demonstrates a sort of personal involvement when confronted with a badly labeled graph that goes beyond only criticizing it as bad practice. Performing a scientific presentation in this way, for him, seems to be a kind of attack against the community of listeners as a whole. Being able to argue — in this way or in others — signifies again a certain kind of knowledge that we might call 'argumentative knowledge.' There are of course much stronger forms of argumentation than merely 'backing' a claim by stories and experiences. Therefore, it would be better to again distinguish different forms of 'argumentative knowledge,' ranging from telling one's own experiences up to a strong deductive syllogism or a mathematical proof. At this point, there is no need to distinguish these forms more precisely. It should be clear that our decision to argue in a certain way always depends on knowledge about the respective situation: L's sense for the interview situation seems to be that some reasons regarding the importance of labeling axes are needed but that it should not be necessary, among scientists, to formulate any stronger arguments.

3.2. Interpreting a familiar graph

We now compare this 'interpreting unfamiliar graph' situation with L's interpretation of a more familiar graph featuring different distributions of electron charges in four shells that can be used to make inferences about the differential ionization energies for each shell (Figure 6). After reading the text next to the graph, L began thinking aloud:

L: So these distributions are ah the same thing as saying that these are distributions that tell us in quantum mechanics that — this is a probability (he puts left hand index at the formula besides the y-axis) of finding an electron at a certain radius (hints with his pen at the end of x-axis). That's what it is. And um... but a graph like this tells you — I mean quantum mechanics... an electron as long as you don't measure where it is can be potentially at many places. And all you know is the probability where it's gonna
be. So these curves tell you where an electron is likely to be in terms of the distance from the nucleus (see Figure 7) or given a certain excitation level of the atom. Okay. Um, these are called shells. Now hydrogen-like atoms mean it could be an atom that has many electrons, and these are the various shells.

Figure 7. Interpreting a physics graph

3.3. A specific difference: The role of playing

Our data reveal a further form of practical knowledge relevant in and to unfamiliar situations: it might be called ludic knowledge (from the Latin ludere, to play), that is, the ability of tackling problems by playing with different ideas, by trying this or that, driven mostly by vague associations that emerge when we are looking around, when we do not interpret a situation — or its representation, like our graphs — by a fixed method and strategy but by drawing from quite different things (cf. Roth 2004). In one episode, L tries to interpret an unfamiliar graph from biology in this way. He generates lots of text, sometimes in a quite chaotic manner, without asking whether what he says is adequate or not — many interpretations that actually are quite inadequate from biology's point of view. He also changes his interpretations sometimes within minutes. Once, for instance, he reads the x-axis of a graph implicitly as if it signifies a time axis, although he correctly interpreted the same axis only a few minutes earlier as representing the size of a population. What appears to be important is the playful generation of material for interpretive possibilities in subsequent more purposive investigation. This kind of ludic knowledge seems to be most important, for it kept L moving even when he reached apparent dead ends. Our emphasis on this kind of unsystematic playing as a form of practical knowledge stems from the fact that there exists already lots of literature about very specific heuristic methods we can use when confronted with a problem (e.g. Polya 1990[1945], 1954, 1962–1965). Our aim is not to repeat these forms or to provide a 'complete' overview of all possible forms of knowledge. Rather, we focus on a general sketch of what we conceive of as the most basic distinctions. Based on those distinctions, further analyses can be performed by the technique of zooming whereby events of different spatial and temporal range are brought into focus (Roth 2001).
3.4. Focal and collateral modes of knowing

The forms of knowledge we have identified so far are, first of all, propositional knowledge — including strategic and ludic knowledge — argumentative knowledge, self-knowledge, and situation-specific knowledge. These knowledge forms are important in cases of unfamiliar situations as well as in cases of familiar situations, but we can make an important distinction here. When L explicitly refers to strategies, methods, and his role as a teacher, these forms of knowledge are in his focus of attention, whereas they are in the background when he concentrates on the reality described by the second graph. To grasp this distinction that is important for a construction of ‘knowledge networks’, we suggest a distinction between (a) focal knowledge, that is, knowledge that is explicitly in focus because it is problematic in some way and (b) collateral knowledge, literally knowledge that ‘runs side by side’ with focal knowledge (cf. CP 8.183, 6.338, 8.314). Similar concepts are ‘knowledge by acquaintance’ (Russell 1959 [1912]) and ‘tacit knowledge’ (Polanyi 1983 [1966]). According to Peirce, ‘collateral acquaintance’ encompasses all that knowledge which is precondition for understanding something different. For example, a proper reading of the physics graphs requires knowledge of electrons as distributed entities rather than as solid bodies, the concept of a distribution, mathematical probabilities, and so forth. Whereas the strategy of understanding at first the axes of a coordinate system is focal when L is confronted with an unfamiliar graph, this strategy is part of his collateral knowledge when he begins his interpretation of the physics graph by distinguishing the distribution of electron charges and different radii without explicitly reflecting on the meaning of axes. Without this hidden collateral knowledge, however, it would have been impossible for him to interpret the graph in this way. Collateral knowledge by definition is never given in distinguishable knowledge form. Rather, it forms an indeterminate space of possibilities that can become determinate only by and in the course of interpretation, that is, by focusing on it and making it explicit. The ground, like collateral knowledge, constrains the interpretation of signs without being explicit in the situation.

3.5. Semiotic forms of knowledge

Besides the knowledge forms distinguished so far there is a considerable amount of propositional knowledge relevant here. For example, when L says that in ‘quantum mechanics (...) an electron, as long as you don’t measure where it is, can be potentially at many places,’ he activates propositional knowledge. It is his knowledge, because a sentence like this does not appear in the material with which he is confronted in this situation. The comparison of what an interviewee produces spontaneously in a certain situation and what is given explicitly in the material he ought to interpret might be the best way to identify all those forms of knowledge that become visible in the semiotic means we use. Speaking about ‘semiotic’ means is more general than hinting at knowledge that is represented in language. Language, of course, is the most important semiotic means but there are others as well. L also gestures and thereby, here, uses indexical signs: he uses his finger and his pen to signify certain properties of the graph. Using indices in this way — in gestures, but also in speech when he hints without any specific gesture at ‘these curves’ — presumes again specific knowledge, even if this knowledge is so basic for our everyday life that we do not reflect much on it. For a child, however, considerable interpretation is necessary to learn something trivial as the ‘pointing gesture’ (Vygotsky 1997: 104). Based on this semiotic terminology, we suggest calling it indexical knowledge. The semiotic perspective indeed offers an interesting framework to distinguish further forms of knowledge. If we take Peirce’s semiotics with its highly differentiated semiotic terminology as a starting point (Liszka 1996; Parmantier 1994), we can use his most famous distinction between ‘symbolic,’ ‘indexical,’ and ‘iconic’ signs to distinguish symbolic, indexical, and iconic knowledge. Peirce defines symbolic signs as those signs that ‘will be interpreted ... in consequence of a habit’ (CP 4.531). Usually, we develop such a habit by learning a certain convention. An axis is a particular sign tied to the conventions of using left-right and down-up movements as progressions. If we are able to read an axis label, we have symbolic knowledge with regard to its meaning. According to this definition, each word of our everyday language is a symbolic sign. We know the conventions to use and interpret them in a certain way. Therefore, symbolic knowledge is the basis of any kind of communication.

The distinctive characteristic of iconic signs is their ability to represent relations (EP 2: 13, 17; NEM 3: 887). Thus, not only photographs, footprints, and diagrams are icons, but — with regard to their structural properties — also sentences (according to their grammar) and mathematical equations. Based on this definition of iconic signs, iconic knowledge is fundamental to interpret a graph. It is this kind of knowledge with permits L’s interpretation of the axes in our examples as the essential parts of coordinate systems. In a further interpretation task, it becomes visible, for instance, when L focuses on certain symmetries in unfamiliar graphs as starting point of his considerations.
Symbolic, indexical, and iconic knowledge seems to be most fundamental for navigating knowledge boundaries. Knowledge of symbols — not only scientific signs, but any concept and word we use for communication — knowledge of how to guarantee 'identity of reference' by indices (Otto, in press), and knowledge of structures and relations are essential means we use in unfamiliar situations to cope with problems of interpretation.

3.6. Knowledge with regard to situations

To apply symbolic, iconic, and indexical knowledge in an adequate manner, we must know at the same time the situations to which an application is possible. For instance, when we are learning the vocabulary of a foreign language, it is not enough to know only the abstract meanings of words. We have to know which word fits to what kind of context. Or to use a city map, we must know beforehand where we are on the map and in the city. We suggest calling this knowledge of situations. It is just this form of knowledge that has been made salient by the 'situated cognition' literature (e.g. Brown et al. 1989; Kirshner and Whitton 1997). In addition to this literature, however, we think it is important to distinguish more precisely between 'knowledge of situations' and situation dependent knowledge. It may, for instance, be impossible for me to describe the way to a certain place. But when I am going, some features of this way (houses, trees, signs, etc.) remind me exactly where to go next at each position of my way. Thus, part of 'my' knowledge is, in a certain sense, located in the world outside of, my situation dependent knowledge exists only in the interaction with certain situations, respectively (Roth in press). Learning in the form of apprenticeship (Collins et al. 1989; Lave 1998; Lave and Wenger 1991) can be interpreted in this way.

A most important case of such a knowledge that is given in interaction with something 'outside' can be observed in using language. Language 'contains' considerable knowledge, that is, our individual knowledge is formed essentially by the possibilities given in our languages. This is particularly evident when we think about cases where knowledge located in our language contradicts our scientific knowledge. Given the pervasiveness of talk about sunrise ('the sun comes up over the horizon' or 'the sun rises') and sunset ('the sun goes down'), for example, it should come as little surprise that children infer that the sun revolves around the earth. Rather than being misconceptions (e.g., Vosniadou and Brewer 1992), children's ('erroneous') statements about the sun and earth are better understood as interpretations of everyday talk.

Situation-dependent knowledge may also be adaptive, that is, leading to different results in different situations. Well-known examples are dialogues or interviews, where other people co-determine the situation. By contrast to other forms of knowledge, situation dependent knowledge exists only when we are within a certain situation. Roth and Bowen discuss something very similar as "an ecological approach to external representations. [The proponents of this approach] assume that in many situations the information in the environment is sufficient to specify all object and events, and the end product of perception is not a representation of the environment but rather that the invariant is directly picked from the environment without internal processing" (Roth and Bowen 2003: 468).

3.7. Intersubjective, shared knowledge

A very special form of situation dependent knowledge is what we suggest to call intersubjective, shared knowledge. It is most important to explain the genesis of knowledge in communication and interaction. Due to its dynamic and fleeting character, however, it is not easy to observe since what we can observe in joint activities are only expressions and actions of the participating persons. What we have in mind, however, is a form of knowledge that is not primarily located within individual persons but within a group or a couple of people. We already hinted at philosophical approaches to formulate something like a 'collective epistemic agency' (Tollefsen 2004) and at the concept of 'knowledge taken-to-be-shared.' This kind of knowledge is supposed to emerge socially during processes of negotiating the meaning of concepts in communication (Voigt 1998).

The open question is whether intersubjective, shared knowledge can be ascribed directly to a group (e.g., Tollefsen 2004) or only indirectly by saying that the individual members of such a group assume that there is a jointly shared knowledge that exists distinguishable from their own individual knowledge. In the first case, shared knowledge would be immediately that of a group, while it would be known only mediated as such in the second case — mediated by the hypotheses and reflections of individuals. In this case, knowledge is not really shared; individuals only interpreted it as being shared. If we admit the possibility of unconscious interpretation, this second case — which is less problematic from an epistemological point of view — should be strong enough to explain the possibility of learning by communication and interaction. This form of interpretation is characteristic of plants and animals and has led to phytosemiotics (Kull 2000) and zoosemiotics (Sebeok 2000), respectively.
This question is interesting enough — and important enough when we think about the relevance of shared knowledge for all kinds of social interaction — to consider it a bit more thoroughly. In the following, we analyze a very short interview sequence featuring the science teachers ‘Kara’ and ‘Tara’ in the attempt of interpreting an unfamiliar ecology graph (Figure 8). It is a collaborative endeavor whose analysis shows not only something about how intersubjective knowledge works, even if the resulting propositional knowledge may not seem very remarkable, but it gives us also an opportunity to propose a more recent methodology — the analysis of pitches in prosody — that can be used to compare dialogue situations with regard to the grade of consonance between partners.

It is well known that in oral communication there are various ‘subtexts’ besides the text that is given in a simple transcription. We understand if there is any irony, mockery, or dissociation of the speaker from what he is saying even if there is nothing visible in the plain text. Based on this observation, our thesis is that we also have a sense for the existing degree of harmony when we are engaged with others in a discussion or cooperative effort. The idea is that the opening up of creative possibilities we sometimes powerfully experience in a ‘really good communication’ depends first of all on an intersubjective, shared knowledge with regard to this sort of consonance or dissonance (Collins 2004; Turner 2002). Maybe, this form of knowledge is a most important part of our collateral knowledge when interacting with others. One of its more curious characteristics seems to be that you cannot improve this knowledge by reflecting on it in a communication. It seems to be a very basic sense. Furthermore, what is known in this way can change over time, be intensified, or disappear and get lost. In the following excerpt, Kara and Tara (Figure 9)
population is increasing

K: [Why?] =right here

T: [It goes] down

T moves pencil tip from peak along birthrate graph to right intersection

Tara was beginning to speak after a pause in their conversation, but immediately after uttering ‘So’ with a dropping pitch contour, she pauses. Such pauses, especially after a speaker has a, for end of sentence typical downward pitch contour is heard by coparticipants as ‘I have finished.’ It is therefore not surprising that Kara begins to speak at this point, but Tara restarts simultaneously repeating the ‘so’ followed by ‘here’. At this point Tara stops and Tara continues developing an idea. Although some may think that very little happens, a tremendous amount of knowledge is needed on the part of both speakers to make this interaction possible. These first four lines of the transcript are only possible if the interaction participants have specific social knowledge that they exhibit implicitly in their discursive and gestural actions, but which is in most cases not present to everyday consciousness. For example, Tara begins to talk simultaneously with Kara. Kara stops again and thereby allows Tara to articulate an idea without the interference of her own talk. In stopping, she also signals that she listens to what Tara has to say rather than being concerned with developing an idea herself. Tara, on the other hand, can assume that Kara is listening, and that she has a metaphorical space for developing her idea without further interruption. Thus, when she leaves another pause of about the same extent as the previous one, Kara does not attempt to begin.

At a later moment, the ownership of the turn is clearly indicated as Tara has her hands on the diagram, whereas Kara is leaning backwards (Figure 10). Kara exhibits that she is leaving the speaking turn to Tara, who knows that this is the case and therefore speaks — if this was not the case, trouble would emerge as both would attempt to speak simultaneously. When Tara takes the next major speaking turn after the episode presented here, her hand moves to the graph again, thereby exhibiting that she wants a turn, and Tara stops talking permitting a change in turn at talk.

Already at the very beginning of the episode, the two make available to another that they are attending to the same issue by the placement of their respective pencil tips. By focusing on the graph, they also exhibit to one another that they are engaging in this activity, producing a graph interpretation for a research project. Their focus is mutual, and in the mutuality they make available to one another that they know the other one does too. If they were attuned to different foci and be conscious of the difference, they would make this available to one another (Roth and Lee 2004).

The issue of beginning before the other has completed is salient, too, in other parts of the transcript. For example, despite the long pauses in turns 13 and 15, Tara does not begin to speak. She knows that Tara has not completed her turn, and Tara knows (implicitly) that she can continue because she has not made available to Kara that in fact she has finished. Such signs of completion are made available to the other by means of prosody — a resource in communication that has not yet received sufficient attention (e.g. Goodwin et al. 2002). On the other hand, the pause in turn 17 follows a turn in which pitch continuously decreases from 225–228 Hertz in ‘population’ to 199 Hertz toward the end of ‘increasing.’ This therefore can be heard as an end of sentence similar to the falling pitch contour in turn 01. Again, Kara orient to the conversation as if she could take a turn, which the combination of sentence structure and pitch has not given her between turns 12–16.

Kara queries ‘Why?’ (turn 19), but Tara, who apparently completes her statement does not respond, although there was a pause. Kara reiterates the utterance, thereby displaying that an assumption that Tara may not have attended to her earlier query. Tara completes the articulation of an idea, because previously she has not provided an indication of the particular part of the graph where the population is increasing; both already have established prior to this episode that there are parts where the population is decreasing because of death rates that are higher than the birthrate. ‘Right here’ (turn 20) together with the action of filling the area between the two curves and to the left of the peak in the birthrate with pencil strokes (Figure 10).

Kara knows that the pencil marks designate the area where the currently articulated idea describes the population as decreasing; she displays this knowledge when she draws the implication that the population should go down when the birthrate goes down (incorrect from a scientific and mathematical perspective). In her display she makes available her knowledge to Tara, who therefore knows that Kara knows even without
having made this knowledge explicit. Their common knowledge is much more fundamental, as evidenced by the fact that they hear certain sounds as questions; and they exhibit hearing a question as a question and willingness to respond at the same time.

Let us look at turns 22 and 23 to analyze this more thoroughly. Figure 11 exhibits the speech intensity and pitch contour for these turns. Kara signals more than just any question. It is a question about what has been said, that is, about the population increasing to the left of the birthrate peak but within the range where it exceeds the death rate. Equally, Tara signals cooperative intentions by matching pitch level and pitch contour of the previous speaker. If her pitch level departed considerably, then the response would be heard differently—depending on the circumstances, as unwillingly responding (Roth and Middleton in press), competition (Goodwin et al. 2002), as mocking the previous speaker (Couper-Kuhlen and Selting 2000), and so forth.

Based on this kind of empirical research we infer that the matching pitches in turns 22 and 23 indicate that Tara tries to get in consonance with Kara, and to make this ‘visible’ for Kara at the same time (Roth 2005). Both interaction participants know this even without having to bring it to their conscious awareness or talk about it. Even such brief interactions such as the one featured here are not possible unless both speakers share certain knowledge about how to interact, what to do when there is trouble (e.g., during overlapping speech), and so forth.

They know something about the graph, exhibit this knowing, and know that the other knows, even though they do not talk about the knowledge and knowledge about knowing. For example, Kara exhibits that she knows by displaying insight in uttering ‘Oh yea,’ with rising pitch on ‘Oh’ and subsequently falling pitch to return to normal pitch range (e.g., Roth and Middleton in press). She has an insight and articulates it: Tara signals agreement by repeating the statement both discursively and gesturally (turn 25) and by matching the pitch trajectory, though more compressed given the shorter time period (Figure 11). In this, the two women have arrived together at an interpretation and each knows that the other knows that they share this knowledge. They make available this knowing about each other’s knowledge in a variety of forms, though not directly addressing it in the content of their utterance.

So far we have highlighted and analyzed many signs of different kinds—words, gestures, pitches—that Tara and Kara make available to one
another and therefore also to the analyst. We can therefore infer that the kind of intersubjective, shared knowledge salient in this situation is also known to Tara and Kara, based on a series of implicit interpretations. In this way, the knowledge generated in this situation would not be immediately 'shared' between both, but mediated by interpretations. However, the mutual exchange of signs is so dense, and there are so many different semiotic 'channels' involved, that both can be quite sure that their individual interpretations of what is 'shared knowledge' between them is indeed shared. This is sufficient for opening up all the creative possibilities of communication and social interaction that we want to highlight by the term intersubjective, shared knowledge.

3.8. Knowing ourselves

Besides these forms of knowledge, we hinted already at self-estimation and self-assessment, that is knowledge of ourselves. It is well known that knowing our social roles is an important feature of forming and stabilising social order and relations. Kara and Tara each know that they have a symmetrical relation with respect to one another but a different one to the interviewer: They have been asked to provide a reading of the graph before them for the benefit of the interviewer. For navigating knowledge boundaries, however, further aspects of knowing ourselves like self-confidence and sovereignty on the one hand and uncertainty and powerlessness on the other seem to be more important. In communication and social interaction again, we know how to present ourselves as a certain character to achieve certain purposes, for example, to influence assessment in an exam (Morgan, in press). In each expression we can find a sort of 'subtext' in which a construction of a certain identity or personality takes place, which constitutes a construction that determines our own acting and thinking as well as that of others who permanently interpret this subtext.

3.9. Embodied knowledge

As a place for some most basic forms of knowledge we should not forget our own body. Our human body, for example, represents 'knowledge' how to walk upright. The ultrasonic orientation system of bats represents a knowledge that enables them to fly more quickly than any visual system would permit. The neural structure of our brain represents evolutionary developed knowledge in the forms of instincts and of fixed modes of perception as described in Gestalt-theory, and so on (Singer 2000). Learning modifies this neural structure as described in so-called 'connectionist models of intelligence' (Elman et al. 1998 [1996]). To summarize all this, we use the term embodied knowledge.

3.10. Summing up

Further differentiations of knowledge forms are possible and our classification only constitutes a beginning. However, we distinguish what appear to be the most important forms of knowledge for processes of life long learning, to 'survive' in the so-called knowledge societies (Figure 12).

The order of lines from the top downwards signifies at least partly certain relations of dependence: it is quite obvious that we need symbolic knowledge to form sentences, and sentences to form arguments. The capacities of our body are surely most basic with regard to all possibilities of knowing. The relation between the other forms of knowledge, however, is less clear. It would be more plausible to assume here rather relations of mutual dependence. For example, iconic knowledge of structures is usually interwoven with symbolic and indexical knowledge when we are confronted with diagrams. Here, we have to interpret at the same time structures, symbols, and indices. Further research is required to show how these forms of knowledge are organized as 'knowledge networks' when we are confronted with different problems. Elsewhere, we suggest a more abstract model how to conceptualize those knowledge networks with regard to a better understanding of learning processes (Hoffmann and Roth 2004).

4. A general definition of knowledge

We started by developing a semiotic understanding of knowledge, and by contrasting our approach with the received philosophical definition of knowledge. After having elaborated the forms of knowledge needed to describe how people can navigate the knowledge boundaries between different worlds of experiences, it should be of interest to combine these forms again in a general definition of knowledge. In this, we need a concept of knowledge that is general enough to encompass all forms of knowledge that are relevant within complex situations such as those that we face in our research context. We suggest the following.

Knowledge is what can be ascribed to an agent as a certain ability based on the observation of this agent's habits. Thus, the different forms of
knowledge distinguished above can be understood as different abilities that can be ascribed to individuals, to groups, or ... event to machines. Argumentative knowledge is the ability to perform arguments; symbolic knowledge is present in the ability to use symbols (including the words of our languages) in an adequate manner; strategic and ludic knowledge reveal themselves in certain habits to act; situation-dependent knowledge becomes visible, for example, in certain habits constitutive of the possibility of cooperation; and so on. The concept of habit again can be defined as signifying a general form of acting as it is triggered by a certain kind of situations. A habit is thus no particular event like an action. It is a general form to act. Based on this definition of knowledge, 'learning' can be defined as habit change.

Our definition of knowledge has been developed on the basis of Charles S. Peirce’s pragmatic account of ‘belief’ In ‘The fixation of belief’ (1877), Peirce elaborates the interplay between ‘doubt’ and ‘belief’ as the ‘motor' of developing knowledge since any doubt motivates to question and modify our belief system. 'Doubt is an uneasy and dissatisfied state from which we struggle to free ourselves and pass into the state of belief, while the latter is a calm and satisfactory state which we do not wish to avoid, or to change to a belief in anything else' (CP 5.372). Here Peirce identifies a belief as 'some habit which will determine our actions.' 'Our beliefs guide our desires and shape our actions.' He uses the following example:

The Assassins, or followers of the Old Man of the Mountain, used to rush into death at his least command, because they believed that obedience to him would insure everlasting felicity. Had they doubted this, they would not have acted as they did. So it is with every belief, according to its degree. The feeling of believing is a more or less sure indication of there being established in our nature some habit which will determine our actions. Doubt never has such an effect. (Peirce CP 5.371; cf. Peirce EP 2: 432)

What Peirce says with regard to belief, we suggest to say with regard to knowledge: It 'puts us into such a condition that we shall behave in some certain way, when the occasion arises' (CP 5.373). However, whereas Peirce highlights at other places that 'a belief is an intelligent habit upon which we shall act when occasion presents itself' (CP 2.435), and that 'it is a habit of which we are conscious' (4.53), 'a deliberate, or self-controlled habit' (CP 5.480), we prefer a concept of habit that does not depend on specific 'higher' cognitive capacities. Thus, our use of habit is rather based on a combination of Peirce’s pragmatic account of habit, on the one hand, and Pierre Bourdieu’s considerations of the ‘habitus,’ on the other. For Bourdieu, habitus is a ‘system of internalized patterns that permits to generate all thoughts, perceptions, and actions typical for a culture, and only these’ (Bourdieu 1994 [1970]: 143, our translation). It is a *medio operandi* that determines an epoch’s unconsciousness ‘individually as well as collectively,’ thus mediating between ‘structure and practice’ (ibid. 139; cf. Polanyi 1983 [1966]). While these considerations concerning the habitus’ capacity to open up action possibilities as permitted by ‘internalized patterns’ fits well with our idea of habit, we are more skeptical with regard to Bourdieu’s emphasis that a habitus represents a whole ‘system,’ a network of different action possibilities. The

<table>
<thead>
<tr>
<th>Knowledge Form</th>
<th>Focal</th>
<th>Collateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>argumentative</td>
<td>e.g., the ability to formulate a proof</td>
<td></td>
</tr>
<tr>
<td>propositional</td>
<td>e.g., knowing a definition</td>
<td></td>
</tr>
<tr>
<td>symbolic</td>
<td>e.g., knowing the meaning of 'probability', or of π</td>
<td></td>
</tr>
<tr>
<td>iconic</td>
<td>e.g., how to structure something, or to identify structures</td>
<td></td>
</tr>
<tr>
<td>indexical</td>
<td>e.g., performing and understanding references</td>
<td></td>
</tr>
<tr>
<td>practical</td>
<td>e.g., problem solving strategies</td>
<td></td>
</tr>
<tr>
<td>strategic</td>
<td>e.g., analyzing the axe at first</td>
<td></td>
</tr>
<tr>
<td>ludic</td>
<td>e.g., playing with associations</td>
<td></td>
</tr>
<tr>
<td>of ourselves</td>
<td>e.g., as a student, professor</td>
<td></td>
</tr>
<tr>
<td>of situations</td>
<td>e.g., how to use a word in different situations</td>
<td></td>
</tr>
<tr>
<td>situation dependent</td>
<td>e.g., when language constrains our knowledge</td>
<td></td>
</tr>
<tr>
<td>intersubjective, shared</td>
<td>e.g., the feeling that we are on the right track in solving a problem jointly</td>
<td></td>
</tr>
<tr>
<td>embodied</td>
<td>e.g., the capacities of our visual system</td>
<td></td>
</tr>
</tbody>
</table>

Figure 12. Different forms of knowledge with some examples. Most of these forms can either be in focus or can be hypothesized as an unconscious pre-condition of a focal form of knowledge. Thus, focal and collateral knowledge are two modes in which each knowledge form can be present.
habit is a system of durable, transposable dispositions which functions as the generative basis of structured, objectively unified practices (Bourdieu 1979 [1977]: vii). Whereas for Bourdieu the habitus constitutes the order and structure of societies, our habits must constitute specific forms of acting or it would be impossible to combine habits with specific forms of knowledge.

John Dewey highlighted the functional aspect of habits, that is, on the idea that a habit must be understood as a function of living in a certain environment. Habits 'assimilate objective energies, and eventuate in command of environment... They are working adaptations of personal capacities with environing forces' (Dewey 1930 [1922]: 15). In this way, 'habits incorporate objective conditions in themselves' (Dewey 1930 [1922]: 21). A most interesting implication of this consideration with regard to learning and education is that 'We cannot change habit directly; that notion is magic. But we can change it indirectly by modifying conditions, by intelligent selecting and weighting of the objects which engage attention and which influence the fulfillment of desires' (Dewey 1930 [1922]: 20).

Our argument for defining knowledge forms as abilities to perform habits is not only based on the fact that this most general definition can encompass — in contrast to the traditional concept — all the different forms of 'knowledge' we distinguish here. There is also an argument based on an epistemological consideration, namely on the question of the very possibility to observe knowledge. How can we know that other people 'know' something? How can we know that within a certain culture some 'knowledge' is given while another is not? How can we know of our own knowledge? Independently of how to answer these questions, if we are forced to justify our respective answers, the only way to do this is to hint at certain habits that can be interpreted as signs for a certain knowledge. When we see a student correctly adding 2 plus 2 for several times, we say that he 'knows' that 2 plus 2 equals 4. We do not hint at a singular action, because this action could be happened merely by chance. We hint at a series of actions and interpret them as an expression of a given habit to calculate correctly. Hints at habits, however, means that we can formulate hypotheses only about knowledge as given or not given, because the only thing we can observe are particular actions (which could be caused by quite different reasons; otherwise, also a given habit can be disturbed by several reasons as we knew from exams for instance). Thus, ascribing knowledge to another person and to ourselves is always a risky endeavor. But there seems to be no other way of ascribing knowledge. We have to interpret what is observable.

5. Conclusion

Our list of quite different forms of knowledge has shown, first of all, that there is more to learn than can be formulated in sentences (propositions). To survive in knowledge societies and therefore to be fit for lifelong learning, it seems to be much more important to have practical knowledge and intersubjective, shared knowledge as a precondition to cooperate and communicate with others. These knowledge forms are most important when we are facing unfamiliar situations, and when we have to cope with new problems. In education, these knowledge forms often do not receive the attention that befits their relevance. They are so basic and often unremarkable in our everyday life that it is hard to perceive them at all. They are invisible in our everyday work practices, as Lucy Suchman (1995) pointed out, so that it takes analytic effort to find them out — which we have done in the case of our empirical examples. However, there are now quite sophisticated analytical tools to reveal some of the normally invisible forms of knowledge — for example, the method of pitch analysis reveals the information given in the prosody of speaking, which makes evident forms of knowledge that we have learned during infancy and perhaps already in the womb.

In the transition from one setting to an unfamiliar new setting, different knowledge forms come to be salient changing the relations in the network (Figure 3). It is unlikely that the nature of salient knowledge forms can be predicted with any certainty because of the dialectical relationship that exists between the knowing subject and the transcendental object of its knowing. Furthermore, the activation of knowledgeable actions is mediated by emotions, which in turn is a function of physiological, structural, and chemical states that mediate current mental states (Damasio 1999). Nevertheless, we saw that under certain circumstances, collateral knowledge normally hidden from view is made explicit in situations of breakdown, when the normal habits that work in familiar situations no longer are appropriate.

The philosophical main point is to argue that the knowledge justification problem facing the classic concept of knowledge can be solved by means of a semiotic approach that uses the relativity of interpretation inherent in Peirce’s triadic sign relation (Figure 1) as its fundamental epistemological feature. Peirce's highly differentiated concept of the 'interpretant' permits a differentiated discussion of this problem. We further used this triadic semiotic model to describe the epistemological relationship between knowledge, an object to be known, and a network of knowledge forms that permits and constrains the possibility of knowledge (Figure 3). In the form of collateral knowledge, this knowledge network mediates — as
a condition of gaining and having knowledge — between the respective knowledge in focus and its object in a way as Peirce’s sign mediates between sign and object. In this article, we discussed the idea of a knowledge network only as constituted by the different forms of knowledge we distinguished in the third part above. Elsewhere, we have taken a further step by introducing the concept of a dialectic system to describe the ways different forms of knowledge work together in learning processes (Hoffmann and Roth 2004). What has become clear already, however, is the idea that a development of these knowledge mediating knowledge forms is possible by means of diagrammatic reasoning, that is, by reflecting on them through presenting them in diagrams, and experimenting with them. Putting what is hidden as a precondition of knowledge in the focus of attention offers possibilities of to improve it.

Note
1. The following transcription conventions have been adopted here: Words written in italic signify emphasis, stretched writing means stretched speaking, question marks (?) means that the voice is being asked, followed by a small pause. full stops (.) means that the voice is going down, followed by small pause. Semicolons (;) signifies that there is a change either with regard to the topic in question, or with regard to the grammatical structure of the spoken sentence. By contrast to the full stops, there is no going down of the voice here, so that all sounds as to be spoken within one continuous sentence. A sequence of points (…) signifies a pause of the speaker. All what is written in double parentheses (…) is our comment. Open [] and close square brackets [()] show where overlapping talk begins and ends. Equal signs (=) at the end of one line and the beginning of the next indicates that the two speakers latched, that is, the normal pause between speakers has not been observed. Numbers enclosed in parentheses (1.3.) indicated pauses measured in hundreds of seconds. Of course, using all these signs depends on our own interpretation.

References

On a semiotic understanding of ‘knowledge’ 139


Morgan, Candia (in press). What does social semiotics have to offer mathematics education research? Educational Studies in Mathematics. Special issue on 'The teaching and learning of mathematics: Semiotic and epistemological perspectives.'


—(1976). The New Elements of Mathematics, 4 vols., C. Eiside (ed.). Berlin/New York: Mouton de Gruyter; Atlantic Highlands, NJ: Humanities Press. (Reference to Peirce's New Elements will be designated NEP followed by volume and page number.)


On a semiotic understanding of 'knowledge' 141


Michael H. G. Hoffmann (b. 1961) is an associate professor in the School of Public Policy at the Georgia Institute of Technology (michael.hoffmann@publicpolicy.gatech.edu). His research interests are philosophy, mathematics education, conflict management, and semiotics. His major publications include Die Entstehung von Ordnung. Zur Bestimmung von Sinn, Erkennen und Handeln in der späteren Philosophie Platos (1996): 'Problems with Peirce's Concept of Abduction' (1999), and Activity and Sign — Grounding Mathematics Education (co-edited with Johannes Lenhard and Falk Seeger, 2005).
Abstract

Cet article remet en question une définition de la fiction parue en 1988, dans un ouvrage intitulé « Contribution à une étude du concept de fiction » (Peter Lang). Étant fondée sur la théorie des actes de langage, cette définition présentait en effet l’inconvénient de ne pouvoir s’appliquer qu’aux fictions verbales.

Une nouvelle définition est donc proposée dans cet article, faisant apparaître clairement la fiction comme un concept de nature pragmatique- sémiotique : une fiction est une représentation, verbale ou non verbale, qu’un auteur produit consciemment dans le but de la transmettre à un destinataire. En transmettant cette représentation, l’auteur de la fiction adopte une attitude spécifique, consistant à inviter le destinataire à imaginer un monde fictif dont les caractéristiques sont compatibles avec celles du monde décrit dans la représentation.

Sur la base de cette définition, l’article recense des exemplifications de fictions aussi diverses que possible, selon la nature de leur support de représentation et selon leur fonction, mais il pose la question du rôle des fictions dans notre vie quotidienne et, en particulier, sur la manière dont elles nous apprennent quelque chose sur le monde réel.

Mots-clés : fiction ; fictivisation ; monde fictif ; pragmatique ; représentation ; sémiotique.

1. Introduction

Selon la théorie de la fiction que j’avais élaborée en 1988 (cf. Jacquet 1988 : 255), produire une fiction revenait à accomplir un acte de fictivisation de la situation de communication, modifiant le contexte dans lequel sont accomplis et interprétés les actes de langage produits par l’auteur de