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# FROM ACTION TO WRITING:
# MODES OF REPRESENTING AND KNOWING

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In his book, Before Writing, Gunter Kress (1997) discusses the many modes in which children represent meaning before they master the system of writing. His illustrations include: drawings, some of them coloured in, or cut out and adorned with further material; three-dimensional figures; and - my favorite - a photograph of a 'pillow car', made from two wire-mesh drawers, a pillow, a red toolbox and other objects, all carefully arranged so that the two girls who made it could sit in the car with their doll passengers. Surprisingly, it might seem, it has neither gear shift nor steering wheel. However, as Kress comments, this is "not because this car's makers do not know about them, but because they are not relevant for the purposes of this car's users and makers" (p. 32). The point of the illustrations is to support his central argument: In making meaning with and through signs of various kinds, people - old as well as young - act out of their current interest and put to use in sign-making whatever is to hand. Furthermore, since the sign is almost always a means to an end in some larger activity, usually involving others as well as the signmaker, he claims that "all signs show rationality, logic, human desire and affect" (p. 19).

It is these claims that I want to explore in this chapter. My ultimate purpose is to consider the modes of representation that are available for exploitation in developing understanding in educational settings and, in so doing, I will argue for a broadening of the current limited - and limiting - focus on written text that is typical of most classrooms. This is perhaps ironic in a book honoring David Olson, who has done so much to clarify the potential of writing for

knowing and understanding. Since I moved to OISE in 1984, David and I have spent many hours discussing writing and related issues and I have benefited enormously from his provocative observations, even when I don't agree with them. Indeed, there is nothing so stimulating for one's own thinking as the attempt to construct arguments to counter the opposition. Thus, I do not wish to decry the value and versatility of written text and its role in the classroom. However, like Kress, I believe that children make meaning in many ways before mastering writing and educators need to value and build on these other modes. Before broaching this topic, however, I first wish to consider the perspectives on representation offered by writers from a number of other disciplines.

It is generally agreed that human mental activity has to do with representations but, beyond that, there is considerable difference of opinion on such questions as: Do other species also make representations? If so, for what purpose? What is the nature of representations? Are they stored in the mind and retrieved in a relatively fixed form, or are they created on the fly in response to the demands of the situation? How are representations related to propositions realized in linguistic form? Following Vygotsky's (1981) precept, I shall adopt a genetic approach in my attempt to answer these questions, starting with a phylogenetic perspective from contemporary work in brain science.

## A PHYLOGENETIC VIEW FROM NEUROSCIENCE

While studying the brain activity of rabbits in response to sensory stimulation, Walter Freeman made an interesting discovery. Contrary to the generally accepted view, he found that "the traces of [sensory] stimuli seemed to be replaced by constructions of neural activity, which lacked invariance with respect to the stimuli that triggered them. The conclusion seemed compelling. The only knowledge the rabbit could have of the world outside itself was what it had made in its own brain" (Freeman, 1995, p. 2).

This finding and the conclusion drawn from it may seem to be very far removed from the study of human meaning making; but Freeman argues otherwise. There are important continuities in the evolution of brain structure, organization and function, he claims, that link humans to much simpler organisms even than rabbits and, in developing his thesis, he draws not only on studies of mammalian brains but also on recent work made possible by the development of non-invasive techniques for scanning the activity on human brains (cf. Deacon, 1997; Edelman, 1992).

On this basis, Freeman proposes that, in origin, meaning arises from an organism's activity in fulfilling its needs to find and ingest food, to mate and reproduce its kind and to avoid predators and other threats to its survival. For species that are mobile, this activity requires a 'cognitive map' that enables the organism to orient itself in space and time and this, in turn, is constructed on the basis of the information derived from the organism's actions into the world. As in the case of the rabbit, Freeman argues, information from the sensory systems is incorporated into the cognitive map, constantly updating it. It is also incorporated into the brain's continuing unity of intentionality (i.e. purposefulness) and so contributes to the changing focus of attention and of action.

What an organism 'knows', therefore, it knows as a result of its own actions, which are uniquely situated in space and time. Over its lifetime, it constructs its own trajectory and cognitive map from the genetically determined groundwork by grasping for available sensory input from within and outside its own body. Thus, although to a considerable degree each member of a species shares a common genetic inheritance and a common ecological niche, its intentional structure is unique, as is the 'knowledge' that it constructs.

However, although solipsistic, brains do not exist in isolation. If only for the reproduction of the species, they need to interact with other brains. Furthermore, in the case of humans, in

particular, brains and minds develop in a social as well as a material world. Brains are members of societies, Freeman argues, and this requires them to coordinate their intentionality with the intentionality of others. In part, this is made possible by the fact that the world into which humans act is a cultural world that has been shaped by prior generations of human artifact-mediated activity. And in part it occurs through the attempt to establish mutual understanding while acting into the social world of joint activity, in the course of which human brains create the shared channels, codes, and protocols that make possible the give and take of information in sign-mediated dialogue.

> Thinking is a process by which some pattern [of neuroactivity] is actualized from the intentional structure into meaning and deployed into the world. Thoughts ... enact the emergence of meaning as a set of relations in a place in an intentional structure, in accordance with which representations are shaped by actions into the world. A representation formed and sent by one brain evokes thought that leads to the construction of meaning in a brain receiving the representation. (Freeman, 1995, p. 107)[1]

However, there is no suggestion that the representations themselves persist or become the material on which further operations are performed. On the contrary, representations are constructed for the occasion on the basis of the constantly emerging and developing self-organization of neuroactivity. For Freeman, representations are “actions into the world”, not the contents of an embodied mind.

Nevertheless, although it is undoubtedly the case that all representations, in whatever mode, are created in and through action, some human representations leave a record of their creation that gives rise to representational objects that can have a life of their own. With training, bards and orators were able to remember and reproduce spoken utterances and, with the advent of drawing,

writing and other visuographic modes of semiosis, the demands on memory were offloaded on to representations that had a permanent existence, independent of the action that produced them. The question that must now be considered, then, is: Can such representational objects be considered to contain meaning? And if so, can one, by memorizing the representations created by others, acquire a store of knowledge that can be applied when the occasion arises? On both these questions, Freeman is quite unequivocal: Although representations are intended to elicit thought in others, in themselves they have no meaning.

At one level, Freeman is undoubtedly correct. The text, as physical object, has no meaning other than as a collection of ink marks on a surface or, in the case of a computer file, as images on a screen; and even when treated as a text in a recognizable language, the meaning is not in the text itself but in readers' transactions with the text (Rosenblatt, 1978). And as others besides Rosenblatt have argued, different readers create different meanings in the course of these transactions and even the same reader will create different meanings on the first and subsequent readings of the same text. As a result, the idea that any text has a single unique meaning has had to be abandoned, even by its strongest supporters (cf. Olson, 1995).

However, there is another level at which representations have been considered to have meaning. To Popper (1972), for example, there is a distinction to be made between representational objects, seen as texts in the sense above, and the 'content' that is represented in such texts. Once created, the latter is taken to have a continuing, immaterial existence in what he calls World 3.

> If we speak of Platonism, or of quantum theory, then we speak of some objective import, of some <u>objective logical content;</u> that is, we speak of the third-world significance of the information or the message conveyed in what has been said, or written. (1972, p.157)

Even though they might not be comfortable with Popper's World 3 of immaterial objects, many people would accept the idea of the continuing existence of ideas, theories and supporting evidence, irrespective of whether they themselves were familiar with the 'objects' in question. It is in this sense that we normally interpret references to 'what is known' about a subject or to the cumulative nature of scientific knowledge. Indeed, the very idea of a culture, when considered as an entity independent of the beliefs and values enacted by its particular members, past or present, seems to be based on such an assumption.

Nevertheless, as I have argued elsewhere (Wells, 1999, in press a), such assumptions have no basis in reality. 'Scientific knowledge' and 'what is known' are no more than reifying abstractions, created by the nominalizing process that is characteristic of the synoptic registers of Western theoretical discourse; they are convenient ways of talking that, when unpacked, are seen to refer to the situated activities of particular individuals using representational objects as mediators of their other-oriented acts of knowing in specific situations. As Freeman (1995) argues, "all knowledge originates in the brains of individuals" (p. 2) and representation is the "product of behavior that is used to cross the solipsistic gulf" (p. 6).

## A CULTURAL HISTORICAL PERSPECTIVE

If rabbits make representations through acts into the world of other conspecifics, what more human beings? In Origins of the modern mind, Merlin Donald (1991) sets out to trace the development of representation from apes to modern humans. The gist of his argument is that, over the course of this evolutionary trajectory, there have been a number of major modifications of 'cognitive architecture', each associated with a new representational system. As he puts it, "Humans did not simply evolve a larger brain, an expanded memory, a lexicon, or a special speech apparatus; we evolved new systems for representing reality." What is more, "each successive new representational system has remained intact within our current mental

architecture, so that the modern mind is a mosaic structure of cognitive vestiges from earlier stages of human emergence" (pp. 2-3).

## Episodic Culture

The starting point for Donald's proposed trajectory is the culture of the australopithecines, approximately four million years ago, which can be plausibly reconstructed from the cognitive achievements of contemporary great apes. This he describes as an 'episodic' culture. Higher primates, as we know them today, are extremely adept in the realms of event perception and episodic memory. Chimpanzees, our nearest relatives, also have social structures that depend upon remembering large numbers of individually learned dyadic relationships; they also have a nuclear family structure, with division of labor and sharing of food. The same would equally have been true of the earliest hominids, he argues and, as with chimpanzees, these characteristics would have required the ability to perceive and remember complex events and to use this situationally-based knowledge to guide their actions.

However, episodic culture has serious limitations. Despite their skill in the analysis and recall of situational information, higher primates cannot deliberately construct representations in order to elicit thinking in others. They have no 'semantic' memory and, as a result, they cannot re-present a situation to reflect on it, either individually or collectively. It was thus the emergence of the ability to produce conscious, self-initiated, representational acts that marked the first major transition on the trajectory from ape to modern human.

## Mimetic Culture

This transition occurred sometime between two and one and a half million years ago with the changes that can be seen in the culture of Homo erectus. Not only did these proto-humans have a

much larger brain, but they made more elaborate tools, used fire and built shelters in seasonal base camps. They were also able to pass on these procedural forms of knowing from one generation to the next and to transport them as, over many generations, they migrated from Africa into Eurasia. Such achievements obviously required a means of recalling and sharing information in the absence of environmental cues. From fossil evidence, however, it seems clear that Homo erectus had not yet developed language. On this basis, Donald proposes that their governing mode of representation was 'mimetic', using a combination of gesture, mime, facial expression and modulated phonation. Mimesis would have constituted an important advance in that it enabled coordination of joint activity and pedagogic interaction in acculturation of the young.

Mythic Culture

The next transition occurred only half a million years ago, or less, with the advent of Homo sapiens. The major development here was associated with the development of language in the modality of rapid, grammatical speech. However, language did not develop simply because of a further enlargement of the brain or a lengthening of the vocal tract. As Deacon (1997) argues, the development of language and the brain show a pattern of co-evolution, in which the emergence of language was part of a more general pattern of adaptation that, building upon the cognitive achievements of mimetic mind, strove to integrate the unconnected bits of information in a more comprehensive and coherent account of being-in-the-world.[2]

The invention and refinement of spoken language must have brought about a radical change from the cultures preceding that of Homo sapiens. Speech added a new and more powerful mode of interpersonal interaction, utilizing a representational system with greater precision and comprehensiveness of reference to objects and actions and their location in space and time. It also provided means for reflectively connecting events through relationships of purpose, reason

and causality and so for the development of narrative meaning making.

However, according to Donald, the most significant achievement made possible by the use of language was 'mythic invention'. Exploiting the fundamental narrative organization of oral language (Bruner, 1986), language-using cultures began to construct overarching myths in order to explain human existence and its relation to the non-human world. As Donald argues: "Myth is the prototypical, fundamental, integrative mind tool. It tries to integrate a variety of events in a temporal and causal framework. It is inherently a modeling device, whose primary level of representation is thematic." And on this basis he concludes that "modern humans developed language in response to pressure to improve their conceptual apparatus, not vice versa" (1991, p. 215).

Writing and Theoretic Culture

Mythic culture emerged some 50,000 years ago. Underpinning it were the physical, cognitive and interpersonal skills that we still deploy in everyday life, together with the 'dynamic' everyday uses of oral language (Halliday, 1993a), with their bent towards narrative construal of experience. For most people in all cultures, this way of life continued, relatively unchanged, until very recently. This may be somewhat difficult to appreciate, given the changes, particularly of a technological kind, that have taken place in the last two or three hundred years, but these only began to impinge on the lives of most of the earth's inhabitants during the course of this century. However, as with all the transitions that preceded, the emergence of theoretical culture (or 'knowledge society', as it is currently named) did not occur overnight. In fact, the first recorded steps were taken some 4,000 years ago, with the first use of written marks to represent articles traded.[3]

In The World on Paper, David Olson (1994) has given us a convincing account of the way in

which writing developed, first as a means of giving visual representation to the meanings communicated in speech, and only later, in the alphabetic script developed by the Greeks when they adopted another culture's writing system, as a representation of the sounds of speech itself As he points out, it is the representation of meaning, not of sound, that is the crucial feature of writing, and not all orthographies have arrived at the same solution. In contrast to alphabetic scripts, writing systems based on Chinese characters, for example, are logographic (Taylor & Olson, 1995), while others are syllable-based, such as the script invented relatively recently by the Vai (Scribner & Cole, 1981). Whatever the orthography, however, the crucial cognitive consequence of writing was that, because by design it produced relatively permanent artifacts, it also created a medium in which memory could be externalized. As Donald observes: "Visuosymbolic invention ... [created] the exact external analog of internal, or biological memory, namely, a storage and retrieval system that allows humans to accumulate experience and knowledge" (1991, p. 309).

This is not the place to trace the history of writing which, from its origins in accounting, has come to permeate almost all aspects of contemporary life.[4] Suffice it to say that, in addition to its early uses in recording information for administrative purposes - a function that has proliferated and diversified over the centuries - writing has, over time, come to serve two major groups of functions. On the one hand, it provides an external representation of 'mythic' or 'aesthetic' meanings, as in narrative, poetry, drama and history; and on the other, it serves to archive information of a substantive, practical kind, based on observation and investigation, and in this way to provide the basis for 'theory building'. Although this distinction was slow to become marked, and is still blurred in many contexts, the development of the latter function in the form of 'prose' genres (Olson, 1977, 1994b) has played a critical role in the development of meta-activity of all kinds, and represents probably the chief contribution of written representation to the development of theoretical activity. As Olson observes: "What literacy contributes to thought is that it turns the thoughts themselves into worthy objects of

contemplation" (1994b, p.277).

Of course, writing is not the only semiotic modality in which meaning can be given a fixed representation. However, even among the other visuographic modalities there is a similar division of functions. Drawing, together with painting and sculpture - all of which, in their first appearance, antedated writing and numerical notation by many millennia - tend to be used to create evocative, aesthetic representations that still maintain their mythic origins; musical and choreographic notations, although functioning more like writing, also have an aesthetic purpose in allowing compositions in these media to be performed even when their composers are not present to direct them. Mathematical formulae, maps, graphs, diagrams and three-dimensional models, by contrast, are typically used to represent information for practical and analytic purposes. For this reason, these modes of representation, together with prose writing, have played an important role in the development of theoretical understanding.

From this brief review, it seems clear that while the transition to theoretical thinking would not have occurred without the externalization of memory made possible by relatively enduring visual representations, the invention of writing and other visuographic means of representation was not, in itself, sufficient to cause the shift. What was also required was a new reason for exploiting the external memory system, which was provided, in large part, by the emerging interest in scientific investigation, together with the ideological changes that accompanied it, at the time of the European Renaissance (Hacking, 1990). Particularly important among these was the tendency towards the reification of knowledge artifacts (Ueno, 1995), which was itself associated with the creation of a new register of written language with which to represent and communicate the outcomes of scientific activity (Halliday & Martin, 1993).

In sum, although exploitation of the new modes of visuographic representation as external memory devices has clearly been instrumental in the development of our contemporary

theoretical culture, equal weight in explaining the transition needs to be given to the changing cultural values and purposes that have led to the increasing valorization of the knowledge that can be constructed by these means. However, it is probably correct that, as Donald argues, "once the devices of external memory were in place and once the new cognitive architecture included an infinitely expandable, refinable external memory loop, the die was cast for the emergence of theoretic structures" (1991, p. 356).

However, an equally important aspect of Donald's (1991) argument is that although, over the course of the cultural-cognitive transitions that he proposes, the semiotic systems of mimesis, speech, and external symbolic storage (ESS) each powered a new mode of cognitive activity, they did not replace those that preceded, but were additive in their effects. The result is that "our modern minds are thus hybridizations"(p. 356), with a variety of modes of functioning at their disposal; furthermore, most activities call for more than one mode of thinking and require the complementary and interdependent use of more than one mode of representation.

It is to further explore the relationship between representations and knowing that I turn next to the views of Marx Wartofsky, a philosopher of science.

## REPRESENTING AS PRIMARY

Like Donald, Wartofsky was interested in the historical development of knowing. As he put it, "what we take knowledge to be is itself the subject of an historical evolution" (Wartofsky, 1979, p. xiii) which has resulted from the progressively more highly developed modes in which humans have acquired the ability to make representations. However, there is no ambiguity about Wartofsky's conception of what it is to make a representation.

1. Anything can be a representation of anything else.

2. It is we who constitute something as a representation of something else. It is essential to something's being a representation, therefore, that it is taken to be one.

3. From (1) and (2) it follows that a representation is whatever is taken to be a representation; that representing is something we do, and that nothing is a representation except insofar as we construct or construe it as one; and in this, it is precisely the representation we make it, or take it to be.

Thus, although representations are clearly important for Wartofsky, what is primary is the actual activity of representing. Representing, he argues, is a fundamental human activity; it is something we do as an essential means of perceiving and of knowing, and is central to all forms of action. Whether internal or external, then, representations have their origin in the primary act of representing. "They come to be what they are, are sustained or maintained as such, and are exhaustively describable in terms of our own intentions" (1979, p. xxi). Representing is also the distinctively human way of constructing knowledge; it is through the intentional making and using of artifacts of different kinds that we become conscious of our own activity and at the same time come to understand that which the artifact is used to represent.

Wartofsky distinguishes three kinds of artifacts that can function as representations. First are material tools and the social practices in which they are employed; these are primary artifacts in that they are directly involved in the transformation of the environment for the production and reproduction of the means of existence. The first such artifacts were simple tools (knives, spears and pots); today, they include aircraft, computers and automatic banking machines. Such artifacts are not created for the purpose of representing, but they can be so used, particularly to represent the activities in which they are typically involved. The second category consists of those that are created for the purpose of preserving the tools and practices by means of which primary activities are organized, and their motives, goals, and knowledgeable skills passed on to

new participants. These secondary artifacts are symbolic representations of primary activities which they are used to plan, manage and evaluate. Face-to-face mimetic acts would have been the earliest form of secondary artifacts; nowadays they may be in one of a variety of semiotic modes or even in a combination. Finally, tertiary artifacts: these are the imaginative, integrative representational structures (myths, works of art, as well as theories and models) in terms of which humans attempt to understand the world and their existence in it.

Like Donald's, Wartofsky's central thesis is that human cognition has developed historically as a function of the different types of artifact that have been used to represent activity and its constitutive objects and actions and at the same time to allow reflection on the various types of relationships involved. As these artifacts have become capable of representing more complex relationships as well as of remaining fixed in form over time and space, they have made possible more complex modes of perception, action and cognition and the development of more integrative modes of knowing and understanding. As he puts it:

> ... our own perceptual and cognitive understanding of the world is in large part shaped and changed by the representational artifacts we ourselves create. We are, in effect, the products of our own activity, in this way; we transform our own perceptual and cognitive modes, our ways of seeing and of understanding, by means of the representations we make. (1979, pp. xx - xxiii)

Like Freeman, Wartofsky also emphasizes the active, social nature of representing - of making representational artifacts to mediate activity with others. Furthermore, as he points out, it is through the attempt to make such representations with and for others that we make meaning for ourselves and, in the process, develop an understanding of our experience of being-in-the-world construed in terms of the theories made available by, and appropriated from, other members of our culture. As Vygotsky so aptly suggested, "the individual develops into what he/she is

through what he/she produces for others" (Vygotsky, 1981, p.162).

## REPRESENTING AND KNOWING

In the previous sections, following Freeman, Donald and Wartofsy, I have argued that it is the activity of representing that plays the defining role in characterizing human cognition. We represent those aspects of the world that are currently of interest to us. And because with each advance in representing, the previous modes were not lost, we have a repertoire of modes to hand for representing what is of current interest. In some cases, this involves pressing into service cultural artifacts that are already available, as when we refer to or quote from others' work or, as in the case of Kress's daughter, by arranging items of furniture to represent a car. On other occasions, we may create novel artifacts in any of the semiotic modalities that we have mastered, for example by composing a written text or by taking a photograph. Often, we make use of a variety of artifacts in a complex interdependency, as when we consult a work of reference, exploit a metaphorical connection in speech to explore the significance of what we have read, simultaneously gesturing to clarify our meaning, and then go on to create a visuographic representation of the relationship thus grasped.

I want now to propose that the same arguments apply to the activity of knowing, since this is mediated by representational acts of various kinds. Just as Wartofsky observes that "there is no human knowledge without representation" (1979, p. xviii), I argue that the same is true of knowing. Furthermore, knowing, like representing, is always situated in a particular moment in relation to the activity that it furthers. In fact, knowing is best understood as a central mode of participating in any ongoing activity. Sometimes it is conscious and deliberate, as when solving a problem, and sometimes it is an operation, routinized and below the level of conscious attention (Lave & Wenger, 1991; Leont'ev, 1978). Viewed in this light, knowing is the use of one or more representations to mediate the achievement of the end in view which, in the theoretical

mode, may well be to create a further representation. This being so, we can distinguish modes of knowing in the same way as Donald and Wartofsky distinguish modes of representing (see Table 1).

**Modes Of Knowing: Phylogenetic And Cultural Development**

| Time BP | Mode of Knowing | Participants | Donald (1991) | Wartofsky (1979) |
|---|---|---|---|---|
| App. 2 million years | Actional | Solo individuals | | Primary artifacts: Found objects as tools |
| 1 -- 1.5 million years | Procedural | Between individuals while engaged in joint action | Mimetic | Secondary artifacts: tools and practices; mimetic interaction |
| 50,000 years | Substantive | Among members of a cultural group, reflecting on action and as a basis for planning further action | (Linguistic) | Secondary artifacts: representations of tools and practices; spoken interaction |
| 50,000 years | Aesthetic | Among members of a cultural group, making sense of the human predicament | Mythic | Tertiary artifacts: artistic represent-ations in myth, narrative, graphic, and musical modes |
| 2,500 years | Theoretical | Among members of a specialist community seeking to explain the natural and human world | Theoretic | Tertiary artifacts: decontextualized representations, such as taxonomies, theories, models etc. |
| ? | Metaknowing | In groups or alone when considering and evaluating alternative strategies or understandings | | Goals, plans, strategie insights into one's ow others' ways of know using knowledge in ac |

Table 1 proposes two modes of knowing for which there is no direct warrant in the work on which I have been drawing. The first of these concerns what I call 'substantive knowing'. In each domain of everyday experience, we construct piecemeal representations, often in language, of objects, persons and events, organized in terms of the activities in which they are involved. These are the 'facts' that are shared by co-participants in an activity system, along with the relevant procedural knowing. In their discursive organization such linguistic representations are 'dynamic' rather than 'synoptic' (Halliday, 1993b), or 'narrative' as opposed to 'paradigmatic' (Bruner, 1986), and they make up a large part of what Halliday (1993a) calls our everyday, or common-sense, knowledge, which is derived from our own and other people's experience. These everyday linguistic representations are, in my view, quite different from the genres of myths or overarching narratives that Donald (1991) sees to be the major achievement of the narrative use of speech. For this reason, I distinguish a substantive mode of knowing, which in all probability preceded and provided much of the material on which the more aesthetic, mythic mode of knowing built.

The second addition is that of 'metaknowing'. The family of 'meta' terms ('metalanguage', 'metacognition', etc.) is of fairly recent origin, but the activity of metaknowing itself is probably almost as old as language itself. All languages include terms for referring to linguistic events - nouns such as 'story', or 'argument', and verbs such as 'tell', or 'persuade'. Reflecting on our actions, including our linguistic and mental actions, is a necessary precursor for constructing explanatory representations of them, whether in a narrative or a paradigmatic genre. For this reason, metaknowing cannot be located as one stage in the sequence of phylogenetic development that is summarized in Table 1. It might perhaps be best thought of as orthogonal to the others (Astington, pers. comm. 9 Dec 1998), functioning as a facilitator of each transition from one stage to the next in Donald's developmental model.[5]

Three final points need to be made about the modes of knowing set out in Table 1. First, as with the priority ascribed to representing in relation to representations, it is the activity of knowing that is primary. Knowledge is constructed in the process, but this knowledge does not thereby become a mental object that can be recalled and applied, ready-made, on subsequent occasions; rather it has to be constructed anew on each occasion in order to fit the intentions of the participants and the specifics of the situation in which they act. To be sure, one outcome of knowing is often the production of a representational artifact, or 'knowledge object'. However, as argued by Freeman (1995), such objects do not contain knowledge, although they have the potential to mediate the knowing of others, provided those others can bring the necessary resources to their transactions with them. Even Popper, who clearly thought of knowledge as 'autonomous and immaterial', insisted that to make it one's own requires an active transaction with the knowledge object, "by trying to reinvent it or to reconstruct it, and by trying out, with the help of our imagination, all the consequences of the [object] which seem to us to be interesting and important" (Popper & Eccles, 1977, p.461).

Second, although the different modes of knowing emerged over time in the course of the developmental trajectory of human cultures, the earlier were not supplanted by those that emerged later. All remain available, once mastered, and all are interdependently involved in contemporary activity systems of any scope and complexity, although they may be distributed over different participants and different phases in the activity.

This brings me to the final point. Knowing certainly requires the active participation of individual knowers on each and every occasion but, because of the social nature of activity, it is never an individual achievement, even when carried out in solitary seclusion. Each of us makes use of (some part of) the accumulated knowing of others and of the representational tools and knowledge objects that they have created. In "acting into the world" (Freeman, 1995) we also contribute to an ongoing dialogue, often with others who are engaged in the same activity as

ourselves. In knowing, each of us acts out of our own interests, while at the same time seeking to establish some intersubjectivity of interest with co-participants in the activity. As Kress (1997) argues, too, we also make use of what is to hand, both those resources of the culture that we have mastered and are able to deploy, and also whatever meanings we have personally made or are currently making of our unique individual experience.

## ONTOGENY RECAPITULATES CULTURAL HISTORY

The sequential development of different modes of knowing over the course of human history that I have just traced might at first sight seem to be of little educational significance. However, it begins to take on considerable importance when the parallels are recognized between this sequence and the sequence of intellectual development in ontogeny. Of course, this is not a simple recapitulation; children growing up in a contemporary literate culture are surrounded from birth by artifacts and practices that result from and embody all the available modes of knowing (Cole, 1996). Appropriating existing cultural tools is thus very different from inventing them de novo, as Scribner (1985) points out. Nevertheless, as Nelson (1996) has argued, children during the preschool years traverse similar stages in progressively making sense of more and more complex aspects of their experience, as they appropriate the semiotic tools for representing that correspond to Donald's 'episodic', 'mimetic', 'mythic' and 'theoretic' minds.

Nevertheless, although Donald's stages are repeated in Nelson's ontogenetic account, her main focus is on the role played by the semiotic system of linguistic representation. In this, she has considerable affinity with Halliday, who also ascribes a preeminent role to language: "When children learn language, they are not simply engaging in one type of learning among many; rather, they are learning the foundations of learning itself. ... Hence the ontogenesis of language is at the same time the ontogenesis of learning" (1993a, p.93).

However, in the light of the work reviewed above, I would argue that such a logo-centric emphasis misrepresents the multimodal and 'hybrid' nature of knowing characteristic of contemporary humans. Humans do not "act into the world" solely in the linguistic mode; nor is language the only mode in which the inner 'cognitive map' is represented (Freeman, 1995).[6] Language may be the most pervasive mode for making and representing meaning and, with the mathematical and other notational systems derived from it, it is essential for theoretical knowing. But it is important not to discount the roles played by action, gesture and drawing, as well as the aesthetic modes of music and dance, as modes of representation in which humans establish intersubjectivity of purpose and reference and develop mutual understanding in the full range of activities in which they participate (Lemke, in press; Wells, in press b). So, while I agree with the general thrust of Nelson's argument, I would want to place greater emphasis on the different kinds of artifacts that mediate knowing across activity systems (Engeström, 1990; Wartofsky, 1979) and emphasize their complementarity rather than focusing on one alone. Further, Nelson's (1996) account of ontogenetic development focuses primarily on the pre-school years. In what follows, I wish to consider the implications of the recapitualtionist view for later development during the years of schooling.[7]

## BUILDING ON A SOLID EXPERIENTIAL FOUNDATION

One of the most important consequences of adopting a historical perspective is the recognition that, in the development of human cultures, each advance in construing and representing experience was built on the modes of knowing that preceded. And on a very different time-scale, the same developmental sequence applies in ontogenesis. As each new mode of representation is appropriated from interactions with others and constructed as a resource for intramental functioning, it expands the range of modes of knowing by means of which the individual can make sense of his or her experience.

As we have seen, historically, speech and narrative emerged as more powerful means of representing and communicating the understandings developed by the mimetic mind; similarly writing and other visuographic semiotic modes provided more powerful, externally accessible, means of working on the knowledge developed by the narrative mind. It seems likely, too, that in each case the transition was facilitated by "going meta" on the knowledge base already established (Olson & Bruner, 1996). However, the slow timescale on which these developments took place can easily lead to the cumulative nature of this process being ignored and, ironically, this seems to be most true with respect to the most recent development, that of theoretical knowing. Certainly, once established, the development of theoretical knowing in any field tends to become an independent activity, carried on largely by extending and improving existing knowledge artifacts in the form of theories and models. However, in almost every case, the initial impetus for theorizing had a practical orientation and required a broad base of accumulated observations and experience of the phenomena in question, encountered in the practical activities of everyday life. Furthermore, as Wartofsky pointed out, theoretical models, although temporarily detached from primary activities, do not exist in and for themselves. They are "representations to ourselves of what we do, of what we want, and of what we hope for. The model is not, therefore, simply a reflection or copy of some state of affairs, but beyond this, a putative mode of action, a representation of prospective practice, or of acquired modes of action" (1979, p.xv).

I emphasize this point because, in planning how to induct young people into the culture's valued knowledge, particularly its theoretical knowledge, the approach adopted often ignores the historical nature of knowledge building. Curricula are designed in terms of the internal structure of the knowledge domain as currently understood by experts, rather than by building on the first-hand experience of learners in the sort of everyday practical activities from which that structure was initially derived (Nelson, 1996). Not surprisingly, many learners have difficulty in understanding the experts' decontextualized theoretical formulations and, as has been amply

documented, a high proportion lose interest and abandon the attempt to understand.

Thus, the significance of recognizing the parallels between ontogenetic development and the cumulative development of the modes of knowing over the course of human history is that it reminds us of the solid basis for each advance that was constructed in the modes that preceded; it also reminds us of the continuing interdependence of the modes that make up the intellectual toolkit at any moment in development. As I have argued elsewhere (Wells, 1999), what is required to put this understanding into practice in education is for teachers to find ways of organizing classroom activities so that theoretical knowing builds more organically on the modes of knowing that students already deploy and grows out of their attempts both to solve the problems arising from the specifics of the 'primary' activities in which they engage and to create representations of the understandings that they achieve in the process. Clearly, not every new topic needs to be rooted in procedural, substantive and narrative construals of first-hand practical experience; however, I am suggesting that such an organic, developmental approach should be adopted with respect to each new domain of theoretical knowing that is encountered in school and that, whenever possible, theoretical knowing be put to use in further practical situations. For it is in the attempt to apply knowledge taken over from others that it is most fully understood and made part of one's own resources for future problem solving.

## INQUIRY, TALK AND TEXT

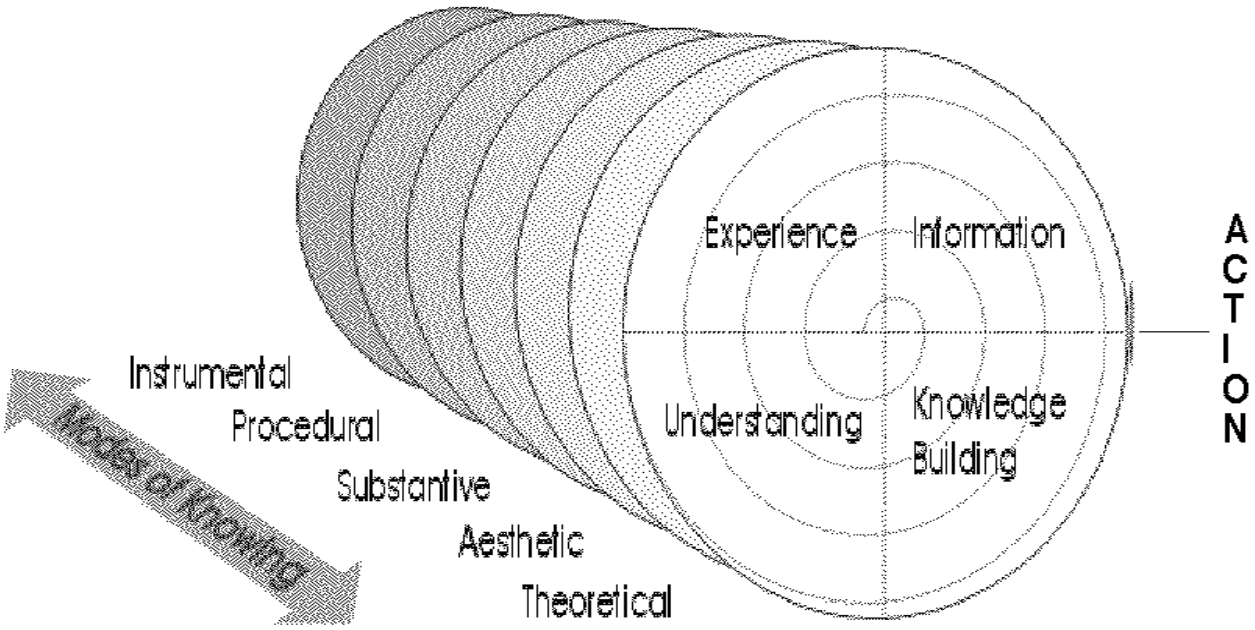
In education, we are concerned with the development of meaning making, that is to say, with enabling people to increase their ability to construe their environment and act effectively in it. In undertaking this endeavor, three principles must be treated as paramount. First, meaning is a process of 'acting into the world' that transforms both the world and the actors. Second, although this process of meaning making is carried out by individuals, it is dependent on, and takes its significance from its role in, collective activity. As Leont'ev observed, the individual's action

only has meaning "in the system of social relations" (Leont'ev, 1981, p. 47). This is related to the third principle, namely that the modes of representation through which meanings are constructed are neither given innately nor invented anew by each individual; rather, they are cultural resources that each individual appropriates from others through participation in joint activity. Individual development thus involves the active appropriation of the practices used to mediate meaning making between people and the personal reconstruction of these practices in relation to one's own unique experience and "continuing unity of intentionality" (Freeman, 1995).

There is a further principle that follows from the interaction of the first three: While what individuals can mean depends on both their personal experiences and the opportunities they have had to appropriate the mediational means that are utilized within the culture, the continuation and renewal of the culture itself depends, in turn, on the unique meanings that its individual members contribute to the local activities in which they participate. Each occasion of activity therefore both reproduces cultural practices and modes of knowing and also to some degree transforms them. There is thus an inevitable but creative tension between homogeneity and diversity, and between convention and invention.

Combining these four rather abstract principles with the arguments developed in the previous section has led us to conceptualize the ideal classroom as a community of inquiry, in which individual development is seen as both occurring through and contributing to jointly undertaken activities that start from the collective's individual experiences and have as their continuing goal the construction of enhanced understanding (Wells, 1999). This can be represented as in Figure 1.

Figure 1: The Spiral of Knowing




This figure is to be read as a spiral, with each cycle starting from personal experience, to which information is added from the environment in the form of feedback from action or symbolically through representations produced by others. The goal of each cycle is to arrive at an enhanced understanding through integrating the new information into the individual's existing 'cognitive map', which is achieved through knowledge building. As the term implies, this latter is an active process of making connections and testing interpretations and conjectures, through action and/or the making of further symbolic representations. As already mentioned, this phase is essentially inter-personal and collaborative. As Bereiter puts it, "the important thing is that the [knowledge building] be progressive in the sense that understandings are being generated that are new to the local participants and that the participants recognize as superior to their previous understandings" (Bereiter, 1994, p.9). If this goal is achieved, each cycle results in an improved and more coherent base of understanding in terms of which to construe further experiences and interpret new information. However, the process is never complete, for with each increase in understanding comes a recognition of how much more there still is to understand (Nickerson,

1985).

The figure should also be read as a spiral in a second sense. Most activities require more than one of the modes of knowing and, as suggested above, when embarking on a new domain, it is desirable to start with experience of everyday practical activities and with the modes of knowing in which they are most readily construed. Moving from shared procedural and substantive knowing to the theoretical mode of knowing, and back and forth between them as necessary, involves another kind of spiral and an interpenetration of each of the modes, as Vygotsky (1987) explained in his account of the relationship between everyday and scientific concepts.

Inevitably, in the classroom, it is linguistic representations that figure most prominently in the inter-personally oriented phases of the cycle, that is to say, in the uptake of information and in knowledge building. However, as both Lemke (in press) and Smagorinsky (1995) emphasize - as do Kress (1997) and Roth & McGinn (1998) - we need to give much more scope in educational settings for the exploitation of other modes of representation and for their use in combination with language.

Nevertheless, it is still in the written mode that knowledge building can most effectively be conducted. As Olson (1977, 1994) and many other writers have pointed out, the great advantage of a written text in this context is that it demands that writers make their meanings explicit, both for themselves and for others - that they make clear how their utterances are to be taken and provide warrant for the propositions that they assert. The other major advantage of a written text is that it is an 'improvable object' (Scardamalia, Bereiter, & Lamon, 1994), a representation of meaning that can be reviewed and revised in an understanding-enhancing dialogue with oneself as well as in collaboration with others. To be most beneficial in its contribution to the development of understanding, then, writing needs to be seen as just one arc in the spiral of knowing, complementing practical activity and exploratory talk and consolidating the basis for

another cycle.

The following example, taken from research carried out in the 'Developing Inquiring Communities in Education Project' (DICEP),[8] illustrates one way in which the principles I have outlined can be realized in practice.

## STUDYING ENERGY THROUGH CONSTRUCTING ELASTIC-POWERED VEHICLES

In a private school in North Toronto, Mary Ann Van Tassell and Barbara Galbraith had, for several years, arranged their timetables so that they could team teach science with their grade two students. Together, they had developed a number of curricular units that allowed their students to explore various aspects of the natural environment through practical investigations that they found interesting and challenging. However, as they reviewed their program in July in preparation for the coming year, the two teachers were not entirely satisfied. When starting each new topic, they had made a point of encouraging the children to think about the questions they would like to answer and these were then written on chart paper and displayed on the classroom wall. What they now realized, however, was that that was as far as these questions went. The activities that followed were almost entirely selected by the teachers, and they were chosen with reference to the questions that they, the teachers, thought ought to be answered rather than to those that the children had actually asked (Galbraith, Reflections, March 1995).

In planning the first science unit for the new year, therefore, they decided to try to allow it to evolve more organically in response to the children's questions; they also intended to become more involved themselves in the resulting problem solving. The theme selected for this new approach was 'energy', to be explored through the making and testing of 'rollers' powered by elastic bands. The children brought from home a variety of cylindrical containers and, following the design found in a children's guide to technology (Richards, 1990), they each began to make

their own roller and to conduct tests to see how far it would travel for a given number of turns of the elastic band. Immediately, however, there were problems. Apart from the difficulties of construction encountered by these seven-year-olds, there were unexpected variations in the manner in which the rollers functioned. In some cases, it took a very large number of turns to get the roller to move at all; others unwound very fast but hardly moved; and some veered to one side or the other. As can be imagined, these problems generated a number of very real questions of an initially instrumental nature. In general, attempts were made to solve these problems as they arose, but they were also addressed more reflectively in the whole class discussions that either started or ended each lesson.

The problem of the rollers that did not go straight gave rise to a particularly interesting discussion. In some cases, the difficulty had arisen because a child had used a container such as a film canister that, with its lid on, had a greater diameter at one end than at the other. In other cases, the problem had been created by adding rubber bands round the circumference of the container in order to give the roller better grip. Part way into the discussion, one of the teachers took one of the rollers that had an elastic band around one end (thus making it slightly conical) and asked the children to predict whether it would travel in a straight line or veer to one side. Most predicted that it would veer, but they were divided as to which way it would circle - to the right or to the left. After it had been observed to circle to the right, I wondered aloud what would happen if the elastic band was moved to the other end. When the adjustments had been made, the children were asked to predict again and then invited to explain their predictions. Most who tried were unable to be at all specific, but Alexandra made an interesting connection:

> I think it will [turn] because on a car if you turn the wheel this way (motioning to the left) the wheels go this way (motioning to the left) if you turn it this way (right) it goes this way (right)

Then the roller was released but, contrary to predictions, it traveled in an almost straight line. Finally, after the rubber band had been moved even further towards the end of the container, another trial was conducted and the roller circled - somewhat erratically - around the end with the smaller diameter.

The teachers had intended to end the unit after experimenting with the rollers. But, because of the children's enthusiastic interest and the indeterminate results of the tests, they decided to extend it further. Following Alexandra's connecting the roller with the wheels of a car, a decision was made to explore the making and testing of similarly powered 'cars'. Again, each child brought from home a small cardboard carton and, with dowel and wooden wheels obtained by the teachers, they constructed vehicles that were powered by an elastic band that was attached to the front of the box and the centre of the rear axle. After a period of general experimentation (and modification of malfunctioning vehicles), it was decided in a general class discussion that the questions to which they wished to find answers were: how far the vehicle would travel for a given number of turns, and whether the addition of rubber bands or Scotch tape as 'tires' would affect the vehicle's performance on the wooden floor as compared to on the carpet.

Since no-one, teachers or children, had attempted such an experiment before, it took some time to develop a satisfactory procedure. One very important invention, proposed by one of the children, was to make a mark on the circumference of one of the rear wheels so that the number of turns could be counted accurately. Conventions also had to be established concerning the use of a tape measure to calculate the distance traveled. Once these procedures were in place, (relatively) systematic trials were carried out by children working in pairs and the results recorded in a chart form that had been collaboratively constructed for the purpose.

At the end of one session, Whitney approached me excitedly. From looking at her chart of results, she had noticed that, for each additional turn of the rear wheels when the car was pushed

backwards, it traveled forwards a further 19 cms - approximately - when released. I asked her if she could think about these interesting results and come up with an explanation by the following week's lesson. When the time came, Whitney did not, in fact, have an explanation (or was perhaps too timid to attempt one in public). However, the problem was taken up in a class discussion and, with the chart of results written up on the blackboard, a collaborative attempt was made to solve it.

Initially, although the children were able to see the pattern, they could not make a connection between an additional turn and the additional 19 cms traveled. In an attempt to help them, I asked one of the children to stand on a tape measure. Her foot was exactly 20 cms long and, as she stepped along the tape, each additional foot-length added a further 20 cms. "So now, what connection can we make?" I asked. At this point there was a rush of suggestions, all of them inaudible because spoken at once, and Matthew, sitting unseen on the floor beside the teacher, made a circular gesture with his hand. Eventually, Lindsay can be heard.

135 Lindsay: The first foot was on- . the first foot was twenty-one . and then her next foot was forty-one, so that's twenty in between . and that's exactly like that (Whitney's results) with nineteen in between

136 Teacher 2: So how does that connect to the pattern?

137 Peter: How much- how long is the box?

138 Teacher 2: How long is this box? (checking) OK, let's measure the box and see how long the box is (taking tape measure and measuring) It's twenty-three centimeters

When it has been generally agreed that it is not the length of the box that is relevant, the teacher prompts them again by asking what else on the car they could measure, but nobody has a suggestion. At this point, I take one of the children's cars and put a drop of ink on the elastic

band that had been added to the marked rear wheel as a tire and push the car across a large sheet of chart paper. With each turn of the wheel, it leaves an ink-spot on the paper. Several children immediately fetch tape measures and the teacher measures the distance between the marks. What follows is worth quoting in full.

157 Teacher 2: Kind of between nineteen and twenty actually

158 Teacher 1: Lindsay?

160 Lindsay: When she <moves> her box . when she's doing that . when she moves
all the centimeters, the reason why it's doing .
Nineteen maybe more is because- ...
(Other children are indicating that they want to speak)

161 Teacher 2: Yes . the distance-

162 Lindsay: - the distance of her turning around her wheel

163 Teacher 1: - is-

164 Lindsay: - is . twenty

165 Matthew: Each time . she winds it back it's twenty centimeters

166 Teacher 1: So . how can we find out . for sure?

167 Carrie: <Count> it?

168 Teacher 1: Of- of what? You've <u>just said the distance</u> of the -

169 Lindsay: <u>Measuring the distance</u> .. back wheel

170 Children: - of the wheel

171 Teacher 1: Measure what?

172 Matthew: Measure um <the distance between the wheels>

173 Sam: Maybe . you can take a tape measure round and round it

174 Teacher 1: Around the wheel?

175 Matthew: Yeah, <u>meas</u>-

176 Teacher 2: <u>Measure</u> around the wheel?

177 Children: Yes

178 Matthew: - and see if it's twenty

179 Teacher 2: Like this? (measuring round the circumference of one wheel)

180 Julia: I don't think it's twenty (she is sitting next to Teacher 2 and can see the measurement)

181 Teacher 2: No, you're right . D'you know what it is?

182 Children: What?

183 Julia: Nineteen

184 Teacher 2: Nineteen

(Many speak at once)

185 Teacher 2: It's kind of between nineteen and twenty

186 Teacher 1: Which is why you get the difference, right? (referring to Whitney's less than consistent results)

187 Charlie: That's why- that's why she's getting nineteen in between

188 Children: Yeah

189 Charlie: That's why she's -

190 Matthew: That's nineteen .. adding nineteen every- every minute

191 GW: (to Whitney) You go and tell everybody because you made this discovery

192 Whitney: (gives her explanation with much hand gesture to indicate the wheel's circumference, but her speech is too soft to hear)

193 Teacher 2: So what would happen if everybody measured . their wheel the way I just measured this?

194 C?: They would see-

195 Matthew: They could see how much it would keep on going . like ***

(Several children speak at once)

197 Teacher 2: You should be able to PREDICT . how far it will go

(Observation, 15 Feb 1995)

As is always the case when classroom activity is systematically observed, there are multiple perspectives from which a curricular unit can be viewed. Here, however, I shall focus mainly on the evidence that the observations provide for the thesis of this chapter. Most striking in this respect, perhaps, is the central role performed by the rollers and cars, first as the outcome of the instrumental and procedural knowing involved in their construction, and subsequently as tools in the shift towards the more theoretical knowing involved in explaining the results of testing them. These 'vehicles' thus functioned both as working mechanical artifacts and as embodied representations of mathematical relationships, which latter role they performed for precisely the reason offered by Wartofsky, namely that that they “carried” information about the mode of their own production and functioning.

Initially, the children’s concern was to have the artifacts work properly and this involved them first in instrumental knowing as they each attempted to construct one, and then in procedural knowing as they assisted each other with those aspects that were proving problematic. Later, this same concern led to a search for ways of getting the cars not to skid on the smooth surface of the floor, in the course of which they generated substantive knowledge about the properties of different surfaces and the function of tires in enabling the wheels to get a better grip. However, from early on, the children were also interested in the relationship between the number of turns of the rubber band as it wound up on the rear axle and the distance the vehicle would travel. This started, as one might expect, in a context of competition, as children sought to outdo each other with respect to the prowess of their respective cars. But it did not take much persuasion on the part of the teachers to turn this into a more general problem, to be tackled experimentally through systematic trials. And it was the pattern that Whitney noticed in her results that led to the discussion quoted above which, from the point of view of the move towards theoretical knowing, must count as one of the most successful episodes in the whole unit. Throughout the unit, then, in their dual role as artifacts and tools, the elastic-powered vehicles not only mediated different

modes of knowing, but they also mediated between the different modes, integrating them in a larger activity structure of doing and knowing.

So far I have said very little about the role of discourse in the collaborative knowledge building that occurred at many points throughout this unit. However, it is very evident in the extracts already quoted, as is the role of the teachers in helping the children to extend and clarify their contributions so that, as a community, they advance towards a shared understanding of the issues that are addressed. It is this goal of achieving a common understanding, I suggest, that, orchestrated by the teachers, enabled individual children to construct their own representations and to respond to, and build on, those of others. One further point, that is not apparent from the transcribed speech, is the multi-modal nature of this discourse. As already mentioned, the chart of Whitney's results, written on the blackboard, played a significant part in the discussion; from time to time reference was also made to other written texts on display - the questions that the children had posed in previous discussions and the interim conclusions that they had reached. But most striking was the mimetic meanings expressed through gesture and posture, as the children used their whole bodies to communicate. Indeed, I would argue that it was Matthew, in his silent circular gesture, who first 'saw' the direction in which the solution might be found. Certainly his contribution at 165, "Each time . she winds it back it's twenty centimeters," suggests that he had by then figured it out, and it is probable that it was partly his desire to share his growing understanding that earlier prompted him to make his unnoticed gesture.

However, in arguing for the quality of the knowing together demonstrated in this episode, I am not claiming that all the children had achieved the same understanding by the end of the unit. From a constructivist perspective on knowing and learning, such an outcome would be most unlikely, since the development of each individual's understanding builds on his or her prior understanding, which itself depends on the range and nature of previous relevant experience. As classes of children are rarely, if ever, homogeneous with respect to prior understanding, identity

of outcome is not to be expected. On the other hand, it is reasonable to expect that each individual will extend or deepen his or her own understanding through the interplay of solo, group and whole class activity and interaction. And this, in the teachers' view, could be observed, over the course of the unit, in the changes in the children's manner of participation and in the quality of their contributions to the discourse.

As a final step in each activity, the children were asked to write in their science journals, reflecting on what they had observed and attempting to provide an explanation. Here is what Alexandra wrote as they were still perfecting their cars:

> Today our group made sure we got acurat answers on how far our cars move. First we looked at Jansens car. After 2 minutes me and katie realizised that Jansons cars wheels were rubbing against the box thats called friction. Then the car wouldent go very far because there was to much friction.

The teachers also made a practice of recording ideas that emerged in whole class discussion on large sheets of chart paper, the exact formulation being negotiated in collaboration with the children. Here, the process of composing the written text helped the children to focus on what was happening, and why; the resulting text also provided a collective record of the group's emerging understanding, to which individual children could refer as they made their own entries in their science journals.

Engaging in writing as well as in talking certainly helped the children to extend and consolidate their understanding of the concepts involved in this investigation of energy. They themselves were aware of its importance as an integral part of 'doing science' and approached it enthusiastically. This was apparent from their comments in the interviews that were conducted at the end of the unit, which included a question asking if writing in science had helped their

learning. Alexandra replied:

> When you write stuff .. You can always remember it and then, when you share in groups you can write more stuff so . so whatever you share you learn more.

In conclusion, two things stand out from the preceding example. First is the way in which the unit as a whole developed from instrumental and procedural knowing, as the children built and tested their vehicles, to a community effort to construct more theoretical explanations of the substantive knowledge gained in the process. And second is the evidence for the crucial role of collaborative knowledge building in each cycle of activity as the means whereby the individual students' experience and the information that each contributed to the discussion were developed into a common understanding.

However, it is by recalling the perspective on meaning making and representing proposed by Kress and reiterated by Freeman that I wish to conclude. As they both emphasize, meanings are actions into the world made out of current interest; furthermore, since a complete understanding of any topic or phenomenon is never fully achieved, they are also made with whatever resources are available to hand - and, it should be added, to mind - however incomplete or inadequate these may be for the purpose. Nevertheless, when interest drives action in an activity undertaken with others there is real motivation to appropriate the resources needed to understand and act more effectively. These are important reminders for those trying to create ideal classrooms.

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**Notes**

1. In this context, it is interesting to see how Halliday describes the ontogenesis of language: "Children are predisposed, from birth, (a) to address others, and be addressed by them (that is, to interact communicatively); and (b) to construe their experiences (that is, to interpret experience by organizing it into meanings). Signs are created at the intersection of these two modes of activity. Signs evolve (a) in mediating - or, better, in enacting - interaction with others, and (b) in construing experience into meaning" (1993a, pp. 94-5).

2. Like Donald, Deacon convincingly argues that language could not have emerged without a co-evolving change in the organization of brain function that predisposed human infants to value symbolic referential relationships over purely indexical ones. Tellingly, he also argues that, although linguistic structure, as described by Chomskyan linguists, may appear to be so complex as to be unlearnable, it has the particular forms found in particular languages because these forms are well adapted to the learning abilities of infant brains: "The key to understanding language learnability ... [lies] in language change. Although the rate of social evolutionary change in language structure appears unchanging compared to the time to develop language abilities, this process is crucial to understanding how the child can learn a language that on the surface appears

impossibly complex and poorly taught. The mechanisms driving language change at the sociocultural level are also responsible for everyday language learning" (Deacon, 1997, p. 115).

3. While writing this chapter, I have been reading a summary of evidence that suggests that a theoretical culture may have arisen as long ago as 12,000 years and, although it disappeared in some catastrophe, it was the knowhow that it developed that made possible the building of the pyramids in Egypt and also in South and Central America.

4. But see Olson (1994b) as well as Goody (1986), Harris (1989), Havelock (1976), and Ong (1982).

5. Another perspective on metaknowing is suggested by Egan (1997), who also adopts a genetic approach to human intellectual development. He proposes a developmental sequence of four kinds of understanding that are mediated by language use: mythic, romantic, philosophic and ironic (there is also a prelinguistic kind that he calls somatic). In this scheme, ironic understanding can be seen as a form of metaknowing in that it results from self-conscious reflection about the language one uses and about the different, and sometimes mutually incompatible, ways of understanding experience that are generated by different modes of language use. However, although ironic understanding has been potentially available as long as language itself, Egan sees its current flowering as in some ways a postmodern response to our twentieth century recognition of the ultimately uncertain and relative nature of all kinds of understanding.

6. The same hybridity also characterizes what Vygotsky (1987) refers to as "inner speech."

7. A somewhat similar case is developed by Egan (1997).

8. The 'Developing Inquiring Communities in Education Project' (DICEP) was initiated with assistance from the Spencer Foundation. The group includes teachers from grades 1 through 8 and university-based educators. More information about the group, together with details of publications (some available on-line) can be found at the project's webpage: http://www.oise.utoronto.ca/~ctd/DICEP

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