Learning and Change from Cognitive and Sociocultural Perspectives: The Issue of Contextual Flexibility

Jeffrey W. Bloom
Faculty of Education
Queen's University
Kingston, Ontario K7L 3N6
CANADA

IN

V. K. Gupta (Ed.)

Science and Technology Education: New Thrusts and Recent Trends

Chandigarh, India: Arun Publishing House
ISBN: 978-81852212296
(1996)

Abstract

The notions of learning and conceptual change have taken on rather narrow meanings in science education research and theory. The purpose of this paper is to explore a wider perspective of individual learning and conceptual change. This perspective not only includes personal cognition, but also includes the wider sense of sociocultural contexts. The dynamics of the interplay between personal cognitive contexts and sociocultural contexts are examined in terms of how learning and change occur. The notion of contexts is used to describe the ways in which various perspectives or understandings can be adopted. Conceptual change is seen as one aspect of contextual flexibility or the ability to see and understand multiple perspectives. Metacognition is viewed as critical to the process of contextual flexibility.

Introduction

The notions of learning and conceptual change have taken on rather narrow meanings in science education research and theory. The purpose of this paper is to explore a wider perspective of individual learning and conceptual change. This perspective not only includes personal cognition, but also includes the wider sense of sociocultural contexts. The dynamics of the interplay between personal cognitive contexts and sociocultural contexts will be examined in terms of how learning and change occur. The first part of the paper will provide a short background on the work that has led up to the thinking in the present paper. Following this introduction, I will describe various notions of contexts. The last two sections of the paper will examine learning and change. Excerpts from data of several studies and personal experiences are used to highlight specific points. Pseudonyms are coded to the age level of the subjects. Children's names beginning with the letters A, B, C, and E refer to the grade levels 1,2, 3, and 5, respectively (ages 6-7,7-8, 8-9, and 10-11). In a similar way, scientists names are coded as B for biologist, C for chemist, G for geologist, and P for physicist.

In previous papers, the theoretical framework of contexts of meaning has been explored as a way in which children, and people in general, personally develop or construct meaning (Bloom, 1990a, 1990b, 1990c, 1992a, 1992b). This framework describes several typological components that emerged from the data of several studies. At the most general level, these components include semantic or formal knowledge,

personal experiences or episodic knowledge, metaphors, interpretive frameworks, emotions-values-aesthetics, and elaboration-imagery. All of these components affect and are affected by cognitive processes, such as inferring, recalling, and so forth. The way in which these components interact with and affect one another contribute to the development of personally meaningful understandings or contexts of meaning.

Some of the components of the context of meaning framework may warrant brief explanations. Cognitive processes are obvious at one level, especially considering the amount of research devoted to the description of such processes (e.g., inferring, elaborating, recalling, categorizing, perceiving, etc.). However, the important notion is that such processes are constantly changing the nature of what children understand by changing knowledge and by adding new information. Interpretive frameworks describe how a certain point of view, belief system, or knowledge set influences various cognitive processes. For example, a child may base an inference about a particular animal on knowledge of other animals (zoomorphism or the assigning of attributes of one type of animal to another). The category of emotions-values-aesthetics was developed to describe what appeared to be the basis of some statements made by children. Each aspect has been combined because of the difficulty in separating them as they manifest in children's speech. A child may be disgusted by earthworms, think they are ugly, and not like them. All three aspects of emotions, values, and aesthetics are strongly associated. Separating them makes little sense in terms of the operational quality of contexts of meaning. Elaboration and imagery refer to the process of creating rich and descriptive verbal or visual "stories" and images.

As various understandings are developed many of them can overlap creating what has been called multiple perspectives (Bateson, 1972; Bruner, 1986). For example, flint can be understood from a geological perspective or context as a form of chalcedony or SiC> 2 . In addition, flint can be understood from the perspectives of anthropology in terms of tools and fire-making, of folklore, of literature, of "a stone to throw," and of "the Flintstones." In addition, each person can have his or her own idiosyncratic meanings attached to the term "flint." From a personal view, flint can have connections with emotions-values-aesthetics, personal experiences, and so forth. Each of these specific understandings (contexts) can contain various components the contexts of meaning typology and can overlap and interrelate with any of the other contexts listed here as well as others.

Contexts

Before proceeding, the term "context", which can hold several different meanings, should be discussed in some detail. In general, context refers to a coherent set of patterns and/or information. Gregory Bateson (1979) defined context as a "pattern through time" and that nothing has any meaning except when seen within some context (this latter point is discussed at length by Hofstadter [1979]). In fact, "without context, words and actions have no meaning at all....What is an elephant's trunk?...The trunk is a 'nose' by a process of communication: it is the context of the trunk that identifies it as a nose" (p. 16). Several contexts can be considered in Bateson's example: (a) spatial context describes the location of the nose on the head; (b) a temporal context describes the function of the nose, which "...[plays] a given part in sequences of interaction between creature and environment" (p. 17); and (c) a formal context which defines the formal relations that make up "nose" (i.e., an embryological definition of nose).

In general, context can be considered as a pattern of information with one or more of temporal, spatial, and formal characteristics. There can be many different levels and kinds of context. However, for the most part I will be using the term in four different, but related, ways. These include (a) cognitive contexts, (b) contexts of meaning, and (d) sociocultural contexts. Although these kinds of context are inseparably related, each one depicts qualitatively different ways of looking at how people think, learn, and communicate. The following discussion will take a closer, but fairly brief, look at each of these contexts.

Cognitive Context

The notion of cognitive context refers to the knowledge and cognition of an individual. Included are not only semantic knowledge and typical cognitive processes (i.e., categorizing, inferring, etc.), but also experiential or episodic knowledge, interpretive frameworks, metaphors, and emotions-values-aesthetics. Cognitive context is the whole of how an individual makes sense of his or her world, of the products of sense making processes, and of how information is used and communicated by the individual.

Emotions and related factors (often referred to under the rubric of "affect") and cognition are not treated as separate modes of operation. In fact, emotions and values are integral parts of meaning-making. They affect knowledge construction processes

(Bloom, 1992b) and are affected by prior knowledge. The cognitive context is the arena in which all that goes on within an individual is considered, used, dismissed, and/or ignored. Everything from initial perception through output and storage in long-term memory falls within the notion of cognitive context.

Contexts of Meaning

As the notion of contexts of meaning arose during my initial studies on this topic, there was no difference between this notion and that of cognitive context Contexts of meaning (Bloom, 1990b) were described as an individual's thinking processes and coherent sets of meaningful information related to the previously outlined components. At present, cognitive processes are seen to create and more or less continuously modify contexts of meaning and, at the same time, are affected by contexts of meaning. A recent paper examines how certain context of meaning components affect specific cognitive processes in the construction of knowledge (Bloom, 1992b). For example, one child's (April's) interpretive framework (environment—attribute relations) guides a causal inference about earthworms: "...they live in the [mud]...and that makes them slimy."

In addition, I no longer consider contexts of meaning as belonging to the individual, rather contexts of meaning may refer to the meaningful understandings of an individual or to the meaningful perspectives of a sociocultural group (see Figure 1). The fundamental assumptions of ihe theoretical framework of contexts of meaning are that: a) meaning involves more than semantic knowledge alone, and may include emotions-values-aesthetics, metaphors, personal experiences, and interpretive frameworks; b) individuals are able to (and should be encouraged to) hold multiple understandings (or perspectives) of phenomena; c) such multiple understandings may conflict with or contradict one another; d) the notion of context refers to the meaning surrounding a particular understanding; e) each contextual perspective or understanding is of unique value and can be useful within a particular social, cultural, or operational context (the "correctness" of a particular understanding is context dependent); f) change is not a matter of restructuring or replacement, but rather a matter of developing more elaborate understandings within a particular context or adding another contextual perspective or understanding; and g) contexts of meaning are dynamic in that they can undergo change almost constantly, particularly when a specific understanding is being engaged.

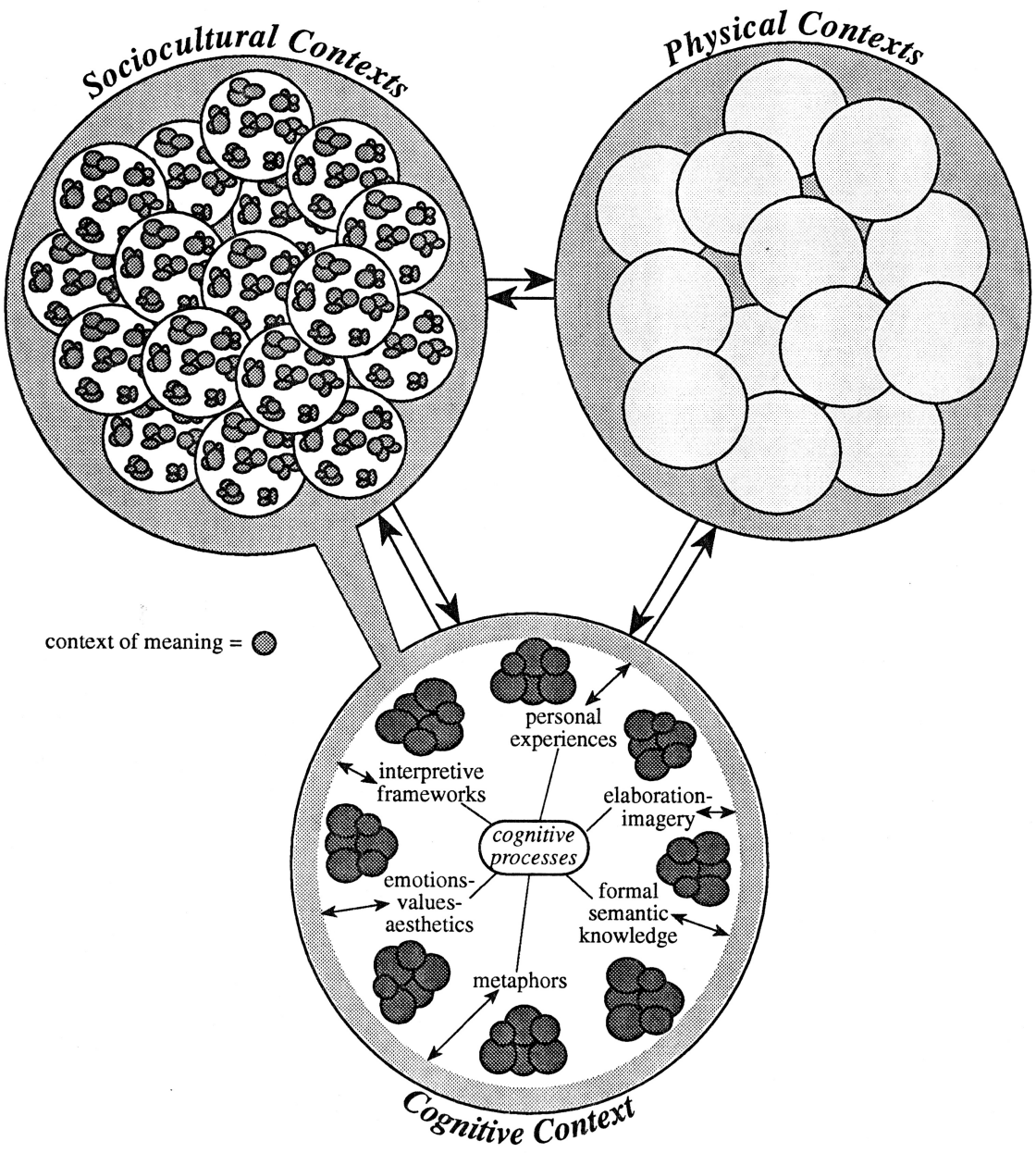

Figure 1. A model of contexts of meaning from an integrated perspective of personal cognitive contexts and sociocultural contexts (as well as, physical contexts).

Sociocultural Contexts

A sociocultural context involves the shared meanings among members of a specific group. Groups of various sizes and differing membership characteristics can overlap in membership. Any single individual can belong to several different sociocultural groups. A particular Vietnamese immigrant living in Texas can belong to the Vietnamese-American sociocultural group, as well as other groups, such as business people, Americans,

Houston residents, Texans, married men, etc. Each group varies in its cohesiveness, membership characteristics and requirements, and so forth, but the shared meanings within each group allow for communication, action, and learning to take place. In other words, many sociocultural contexts affect any particular individual. From the most general level of "human beings" to very specific levels, such as those individuals living in a particular neighborhood, each sociocultural context affects people's cognition in different ways and to varying degrees.

Such sociocultural contexts are created, maintained, and altered by the individual members, and, at the same time, influence, maintain, and alter the group members' individual cognitive contexts. Sociocultural and cognitive contexts are inseparably intertwined. Neither context is "by nature intrinsic or extrinsic to the other" (Shweder, 1991, p. 100). Shweder (1991) refers to the psyche or cognitive context as an intentional person and to culture or a sociocultural context as an intentional world:

> The principle of intentional worlds...asserts that subjects and objects, practitioners and practices, human beings and sociocultural environments, interpenetrate each other's identity and cannot be analyzed into independent and dependent variables. Their identities are interdependent; neither side of the supposed contrast can be defined without borrowing from the specifications of the other, (p. 74)

He adds that "...no sociocultural environment exists or has identity independently of the way human beings seize meanings and resources from it.." (p. 74). Meanings exist within sociocultural contexts as sociocultural contexts of meaning. These meanings are in turn extracted by individuals or cognitive contexts and are modified into individuals' contexts of meaning. Shweder's (1991) notion of cultural psychology is based on two premises: (a) the principle of existential uncertainty (intentional person), which deals with individuals' search for meaning in the sociocultural environment and (b) the principle of intentional worlds (culture), which deals with the inseparability of individuals and their actions within a particular sociocultural environment.

The degree to which different sociocultural contexts affect the cognitive contexts of individuals and vice versa is dependent upon a number of factors. Hofstadter (1979) discusses this aspect of the effect of sociocultural contexts on cognitive contexts:

> We build up our mental representation of a situation layer by layer. The lowest layer establishes t he deepest aspect of the context-sometimes being so low that it

> cannot vary at all. For instance, the three-dimensionality of our world is so ingrained that most of us never would imagine letting it slip mentally. It is a *constant* constant. Then there are layers which establish temporarily, though not permanently, fixed aspects of situations, which could be called background assumptions-things which, in the back of your mind, you know can vary, but which most of the time you unquestioningly accept as unchanging aspects....Then there are "parameters": you think of them as more variable, but you temporarily hold them constant. There could be--and probably are-several layers of parameters. Finally, we reach the 'shakiest' aspects of your mental representation of the situation—the variables, (p. 644)

Those sociocultural contexts that expose and communicate the most fundamental assumptions appear to make the most enduring effects on individuals' contexts of meaning. The variety, nature, and degree of the effects of sociocultural contexts upon individuals contribute to the way in which individuals think, act, and create meaning, as well as to the extent to which individuals can understand varying or multiple perspectives.

Within the notion of sociocultural context we can also consider the human-made aspects of physical contexts and how they influence cognitive contexts (see Figure 1). The physical setting in a school affects the way children and teachers think, feel, and interact (Corrigan & Haberman, 1990). However, the setting in the school was created by individuals, who to varying degrees translated certain sociocultural and personal contexts of meaning into their physical set-up of the school. Within each school, teachers set up and decorate their own classrooms. The classroom setting is again determined to a great degree by sociocultural and personal contexts of meaning. The way in which a classroom is set-up can affect the social atmosphere of the classroom, as well as the cognitive context of each individual (Zimring, 1981, as cited by Seifert, 1983). In turn, the setting can affect how the teacher and the students treat and modify that classroom setting. The classic work of Edward T. Hall (1966) summarized the anthropological view of how humans and their culture are so strongly interconnected with widely differing ways of using space. (Although not dealt with here, we can also consider how the physical setting itself affects cognition. For example, an individual living in a desert is exposed to different experiences of the world than an individual living in a rain forest or by the ocean and so forth.

The "Story" of Learning and Contextual Interrelatedness

The notion of contexts of meaning is distinctive in that semantic knowledge, interpretive frameworks, emotions-values-aesthetics, metaphors, and personal experiences are not viewed as fundamentally different and are seen as interrelated aspects of cognition. Similarly, Bruner (1986) describes how he contended with such artificial divisions of cognition: "...I decried the habit of drawing heavy conceptual boundaries between thought, action, and emotion as 'regions' of the mind, then later being forced to construct conceptual bridges to connect what should never have been put asunder" (p. 106).

One of the major ways in which children put together their ideas, including the different aspects of contexts of meaning, in ways that make sense to them is through stories or narrative. The other way of organizing information is through categorization (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976; Rosch, 1978). The differences between these two ways of organizing is discussed by (Shweder, 1991):

> To say what something is, taxonomically, is to say what it is not, to say what it is a kind of, and to point to instances of it It is to subsume it as a particular example of something more general and to generalize it, so as to turn something more particular than it into its example. To say what something is, narratively, is to describe its origination ("once upon a time") and its density (its aim, purpose, or function) and to comprehend its current status, in the here and now, as part of a longer story of strings, achievements, obstacles, growth, adaptations, failures, dormancy, or never-ending cyclical return, (p. 76)

Bruner (1990) suggests that folk psychology, which uses narrative rather than concept to organize knowledge and experience, is a more constructive way of trying understand how people think and create meaning. Narrative, through "...its sequentiality, its factual 'indifference,' and its unique way of managing departures from the canonical..." (p. 50), can organize information in ways that are not categorical or hierarchical. According to Bruner, cultural psychology takes into consideration individuals' ideas about their mental states and focuses upon action within a sociocultural setting.

Children's narratives reflect such the interplay between personal and sociocultural contexts. Adam's discussion of earthworms is an example of such interplay (interviewer's speech is in square brackets):

> I know what these are...crayfish...I caught a crayfish once. [You did...did he pinch you?] I caught one quite fast. He didn't pinch me. [What are these other things up here?] Do you know how I caught it? [How?] You just take a paddle and... and you put it in front of you and... and the crayfish gets very very scared, and (**) [Yeah] and then... and then you put the net behind it, [uh huh] and you know there's disks, there's the paddle when he gets scared. So he walks backwards [and he walks into your net?] Yup. [that's pretty tricky] He walks right into the net.

Anthropomorphism, emotions, and personal experiences are brought together to create meaning in the form of a narrative or story. The story takes precedence over the interviewers questions, especially the second question, which did not relate to Adam's story. The question we can ask is how much of this story is embedded in sociocultural contexts?

Within the context of story-telling, Bruner (1986) discusses three aspects of narrative that recruit a reader's imagination:

> [1] ...the triggering of *presupposition*, the creation of implicit rather than explicit meanings....
> [2] ... *subjectification*: the depiction of reality not through an omniscient eye that views a timeless reality, but through the filter of the consciousness of protagonists in the story....
> [3] ... *multiple perspective*: beholding the world not univocally but simultaneously through a set of prisms each of which catches some part of it. (pp. 25-26)

Narratives are a way of personalizing, interconnecting, and enriching our understandings of the world. Although categorization schemes play a role in understanding our world, they appear to work in the background and serve as a source of material for our narratives. In citing Polanyi (1958), Martin and Brouwer (1991) contend that personal narratives form the basis for understanding formal or paradigmatic science; how scientists actually do science, including emotional and aesthetic aspects. Martin and Brouwer see the aesthetic as a foundation for narrative as a way of knowing and

understanding science. They refer to "personal science" as that which incorporates the richness of a narrative way of knowing. Dr. Baker's (pseudonym; a biologist in a major North American university) narrative about his view of science is an example of the connection with emotions and aesthetics:

> The aesthetic value is that I find doing science, both its quantitative aspects, the modeling and theoretical aspects, and the joy of investigating the natural world, just watching it, "Hey! Look at this," as rewarding. For instance, I seem oratorial [sic], and tonight, for instance, we are doing the Verdi Requiem and the almost excruciating beauty of that piece to sing. Its the same sort of thing. Its just an enormously pleasurable aesthetic experience....Now mind you in science much of it is associated with a great deal of sweat and hard work and dog work and all that sort of thing, but the thing that drives it all certainly is the aesthetic enjoyment. Within the context of narrative, Dr. Baker relates how aesthetics permeate both his work as a scientist and his interests in singing.

Flannery (1991) discusses the major aesthetic qualities of science as being rooted in the concept of order, which includes the notions of unity, complexity, pattern, simplicity, balance, and so forth. However, the aesthetic not only includes the "beautiful," but also the sublime, the tragic, and grotesque. All of these aspects of the aesthetic share the effect of awakening the senses or awakening the mind.

> Scientific inquiry can itself be an aesthetic experience. It has its dramatic, tragic, and comic elements. It is rooted in the search for the novel: the new discovery, the new explanation, the new theory. It sometimes involves the grotesque, and often has elements of the sublime, (p. 580)

Flannery goes on to suggest that pleasure in science does not always come from big discoveries, but from acquiring each piece of data and conquering the everyday problems that arise.

Contexts of meaning provide multiple ways of knowing our world. Through narratives and categorization, through formal knowledge and personal experiences, through metaphors and emotions-values-aesthetics, we create an intimate knowledge of our world. Some of this knowledge is idiosyncratic, but most is shared within our sociocultural contexts. The more we know, the more we understand the world from different perspectives. As Bruner (1986) suggests,

> we know the world in different ways, from different stances, and each of the ways in which we know it produces different structures of representations, or, indeed, 'realities.' As we grow to adulthood (at least in Western culture), we become increasingly adept at seeing the same set of events from multiple perspectives or stances and at entertaining the results as, so to speak, alternative possible worlds. The child, we would all agree, is less adept at achieving such multiple perspectives-although it is highly dubious...that children are as uniformly egocentric as formerly claimed, (p. 109)

Contextual Rigidity and Contextual Flexibility

Learning and conceptual change can be looked upon as changes in contexts of meaning, both personal and sociocultural. The inability to understand another perspective, such as a scientific explanation or a particular cultural group's point of view, can be seen as a matter of contextual rigidity. Such contextual rigidity is the inability to take on or understand multiple perspectives. Contextual flexibility, on the other hand, refers to the ability to understand another perspective. Such flexibility does not necessarily mean that an individual changes allegiances (from one contextual perspective to another), but it does mean that an individual is able to understand another perspective. Shweder (1991) discusses this sense of change, but with a different end:

> According to the premises of cultural psychology, even the transcendent realities portrayed by scientists are part of intentional worlds and cannot really take us beyond our mental representation of things.... transcendence and self-transformation are possible but only through a dialectical process of moving from one intentional world into the next, or by changing one intentional world into another, (p. 99)

Our expectations of conceptual change teaching are that children's notions of how certain phenomena work will be replaced by (will move from one intentional world into another) a scientific one. I am not suggesting that children cannot come to change allegiances to scientific beliefs. However, I am suggesting that one cultural context or intentional world is not replaced by another. Rather, one's allegiance can change, but the previous context (or conception) does not disappear. Although Shweder claims that one can move from or change one intentional world to another through a process of

reasoning, he offers no empirical support for such a claim. If as he claims, psyche and culture make up each other, then it would be difficult for a process of reasoning to move from or change a culture. When an individual moves from one culture into another, the original cultural representation is not replaced within that person's own cognitive context (psyche). The cognitive context, however, will change (but not change into a new context) as the new cultural context is incorporated along with the old. For example, as a 15 year old, I was entering my third year of intensive interest in and study of sharks. I had just returned from Woods Hole Oceanographic Institute with a live 42 inch shark. After two days in a large tank in my basement, the shark's state of health began to decrease dramatically. As I was discussing this concern with my science teacher, I said, "I'll just have to pray for him." His response was, "I don't think that will do any good." I can still remember the sense of shock and a feeling of emptiness. No dramatic change occurred in my view of the world...immediately. But over time, this event can be looked back upon as a turning point in my abandonment of one sociocultural context (intentional world) as a viable explanation for the way the world works. At the same time, I have not forgotten that particular sociocultural context, and in some ways, I may understand that context more thoroughly.

In most societies, we (including children) are influenced by and are influencing a large number of sociocultural contexts. From a small social context of a group of friends or a classroom to larger cultural contexts of ethnic group, religion, community or region, and national society, each individual contends with representing the dynamic interplay between each contextual demand or influence. These representations and interplay among different contexts occur within a personal cognitive context. The personal cognitive context provides the means for achieving contextual flexibility, for understanding our world from multiple perspectives. On the other hand, our personal cognitive contexts can become "arthritic" in the sense of perpetuating contextual rigidity. New or different ideas are rejected without attempting to understand them.

Understanding multiple perspectives or achieving contextual flexibility seems to be based in metacognitive ability, in the ability to understand one's own thinking. Throwing out another perspective on emotional grounds and without considering it is due to a lack of understanding of how our own thinking works. Understanding multiple perspectives requires an understanding of our own cognitive context, of our own thinking.

Acknowledgments

The research that forms the basis for this paper was funded by grants from the Advisory Research Committee of the School of Graduate Studies and Research, Queen's University and from the Social Sciences and Humanities Research Council of Canada (grant #410-92-0110). A version of this paper was presented at the 2nd International Conference: History and Philosophy of Science in Science Teaching, May, 1992, Kingston, Ontario.

References

Bateson, G. (1972). *Steps to an ecology of mind.* New York: Bantam.

Bateson, G. (1979). *Mind and nature: A necessary unity*. New York: Bantam.

Bloom, J. W. (1990a). *Contexts of meaning and children's understanding of the world*. Paper presented at the annual meeting of the Canadian Society for Studies in Education, Victoria, BC, June.

Bloom, J. W. (1990b). Contexts of meaning: Young children's understanding of biological phenomena. *International Journal of Science Education, 12*(5), 549-561.

Bloom, J. W. (1990c). *Methodological perspectives in assessing and extending the scope of children's contexts of meaning; Context maps and drawing tasks*. Paper presented at the annual meeting of the American Educational Research Association, Boston, April.

Bloom, J. W. (1992). Contexts of Meaning and Conceptual Integration: How Children Understand and Learn. In R. A. Duschl and R. Hamilton (Eds.), *Philosophy of science, cognitive psychology, and educational theory and practice* (pp. 177-194). Albany, NY: State University of New York Press.

Bloom, J. W. (1992). The development of scientific knowledge in elementary school children: A context of meaning perspective. *Science Education, 76*(4), 399-413.

Bruner, J. (1986). *Actual minds. Possible worlds*. Cambridge, MA: Harvard University Press.

Bruner, J. (1990). *Acts of meaning*. Cambridge, MA: Harvard University Press.

Bruner, J., Goodnow, J., & Austin, G. (1956). *A study of thinking*. New York: Wiley.

Corrigan, D. C., & Haberman, M. (1990). The context of teacher education. In W. R. Houston, M. Haberman, & J. Sikula (Eds.), *Handbook of research on teacher*

education: A project of the association of teacher educators (pp. 195-211). New York: Macmillan.

Flannery, M. C. (1991). Science and aesthetics: A partnership for science education. *Science Education, 25*(5), 577-593.

Hall, E. T. (1966). *The hidden dimension*. Garden City, NY: Doubleday.

Hofstadter, D. G. (1979). *Gödel. Escher. Bach: An eternal golden braid*. New York: Vintage Books.

Holland, J., Holyoak, K., Nisbett, R., & Thagard, P. (1986). *Induction: Processes of inference, learning, and discovery*. Cambridge, MA: MIT Press.

Kuhn, D., Amsel, E., & O'Loughlin, M. (1988). *The development of scientific thinking skills*. San Diego, CA: Academic Press.

Martin, B. E., & Brouwer, W. (1991). The sharing of personal science and the narrative element in science education. *Science Education, 25*(6), 707-722.

Rosch, E., Mervis, C. B., Gray, W. D., Johnson, D. M., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive Psychology, 8*, 382-439.

Rosch, E. (1978). Principles of categorization. In E. Rosch & B. B. Lloyd (Eds.), *Cognition and categorization* (pp. 27-48). Hillsdale, NJ: Lawrence Erlbaum Associates.

Shweder, R. A. (1991). *Thinking through cultures; Expeditions in cultural psychology.* Cambridge, MA: Harvard University Press.

Seifert, K. (1983). *Educational psychology*. Boston: Houghton Mifflin.