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Assessing and extending the scope of children's contexts of meaning: context maps as a methodological perspective

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RESEARCH REPORTS

Assessing and extending the scope of children's contexts of meaning: context maps as a methodological perspective

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In the present study, a method for uncovering the richness of meanings and understandings that children bring with them to learning situations is examined in terms of its effectiveness to elicit relevant data. Context maps elicit a more holistic view of the connections between various perspectives of understanding rather than a detailed picture of student conceptual knowledge. Two types of context maps were constructed by 24 grade 5 students on the topics of 'issues facing the world' and 'forests'. The results show that the maps do provide useful information on children's semantic knowledge, personal experiences, metaphors, interpretive frameworks and emotions–values–aesthetics, as well as on how children organize their understandings. The information gathered from context maps tends to indicate highlights rather than specific details. As such context maps are particularly useful in capturing glimpses of the general areas of children's multiple understandings and associated aspects of contexts of meaning (formal semantic knowledge, personal experiences, metaphors, interpretive frameworks and emotions–values–aesthetics).

Introduction

In earlier studies (Bloom 1990a, b, 1992a, b), semi-structured, informal interviews were used to examine young children's understanding of biological phenomena. Analysis of the results led to the formulation of a theoretical framework referred to as contexts of meaning. This framework includes a variety of cognitive components that contribute to children's construction of knowledge and meaning, including formal semantic knowledge, personal experiences, metaphors, interpretive frameworks and emotions–values–aesthetics. In order to understand more fully the meanings and understandings children bring with them to learning situations, it is essential that we find ways of accessing or uncovering the widest possible range of these understandings. In the present study, a method for uncovering the richness of children's multiple understandings or contexts of meaning is evaluated on its effectiveness to elicit relevant data on the various components of this framework.

Background

When discussing 'meaning', from either a psychological or an epistemological point of view, a major assumption is that meaning is semantic in nature (Bloom 1992a). In psychology, according to Macnamara (1982), meaning and concept are rarely distinguished. When Finley and Stewart (1982) discuss learning the knowledge of

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a particular discipline, they suggest (*a*) that meaning is attached to concepts and to the relationships between concepts and (*b*) that the intent is for students to 'learn selected networks of meaning' (p. 595). Consider the following supposition. If information about a certain topic is related or linked together according to logical principles, and if that information is understood, then it is meaningful to the people who understand it. For example, if we were to examine a definition for amphibian, we might encounter the following: (*a*) amphibians are vertebrate animals (which would be linked to characteristics of both vertebrates and animals), (b) amphibians lay eggs underwater, (*c*) amphibians have a three-chambered heart, (*d*) amphibians have moist skin, (*e*) and so forth. if someone were to understand these and associated propositions, then 'amphibian' would have meaning for that individual. However, is such a notion of meaning a complete representation of what actually constitutes meaningful understanding in children? Is there more to personal meaning than sets of related propositions?

The assumption that the nature of meaning is semantic guides the way we design our research and the way we analyse and interpret our data. If we look at the methodological approaches used to explore cognitive structure and meaningful learning, few approaches have considered aspects of cognition other than semantic knowledge. The methodological strategies and approaches that have been employed in recent research include (*a*) informal and semi-structural interviews (Erickson 1979); (*b*) a variety of structured and clinical interviews (Nussbaum and Novak 1976, Albert 1978, Erickson 1979, Nussbaum 1979, Pines 1979, Rodrigues 1980, Klein 1982, Posner and Gertzog 1982, Sneider and Pulos 1983, Carey 1985, Gilbert *et al.* 1985); (*c*) concept mapping tasks (Novak *et al.* 1983, Novak and Gowin 1984, Fraser and Edwards 1987, Hoz *et al.* 1987); (*d*) semantic networking (Fisher 1990); (*e*) concept circle diagrams (Wandersee 1987); (*f*) word association tasks (Battig and Montague 1969, Shavelson 1972, Preece 1976, Rosch *et al.* 1976, Gussarsky and Gorodetsky 1988); (*g*) sorting tasks (Chi *et al.* 1981, Dickinson 1987); (*h*) tree construction tasks (Stewart 1979, 1980); (*i*) a variety of tests (Novick and Nussbaum 1981, Head and Sutton 1985, Amir *et al.* 1987); (*j*) a variety of content-specific and process-specific tasks (Gunstone and White 1981, Finley 1985, Stavy 1987); and (*k*) a variety of more experimental procedures designed to probe into the specific structures and processes of memory (Rogan 1988). Such strategies focus upon semantic knowledge. The results of these studies have been important in furthering our knowledge of children's conceptual understanding; however, the results fall short in providing a more complete view of children's understanding.

Recent studies have described a number of semantic and non-semantic characteristics of meaning associated with children's understanding of certain biological phenomena (Bloom 1990a, b, 1992a, b). Such characteristics are involved in the personal construction of meaning and are referred to, as a whole, under the framework of 'contexts of meaning'. Contexts of meaning can be thought of as dynamic associations of multiple perspectives or multiple understandings. Even with the risk of creating a static framework, it is necessary to formulate a descriptive typology as a working model of the cognitive context within which children make sense of their world. The typology includes (*a*) semantic knowledge; (*b*) personal experiences; (*c*) metaphors; (*d*) interpretive frameworks; and (*e*) emotions–values–aesthetics. The contention is that children construct meaning with more than semantic knowledge alone. Personal experiences are commonly incorporated as significant components in contexts of meaning.

The process of constructing meaning is often dynamic, involving inferring, generating metaphors and analogies, and so forth. Ideas change; new inferences are made; the content and character of contexts of meaning develop and change from moment to moment. In addition, anthopocentric, anthropomorphic (giving an object or animal the qualities or characteristics of humans), zoomorphic (giving an object or one kind of animal the qualities or characteristics of another kind of animal), and other interpretive frameworks, as well as emotions–values–aesthetics, come together to help form deeply entrenched personal meanings and to influence and guide associative and inferential processes. Interpretive frameworks and emotions–values–aesthetics have a strong effect on inferential processes, knowledge construction and meaning-making. For example, an environment-attribute interpretive framework suggests that the environment in which an animal lives affects attributes of the animals itself, and is evidenced in a grade 1 girl's statement about earthworms: 'they live in the [mud]...and that makes them slimy' (Bloom 1992b, p. 407).

Many of the existing methods for investigating children's understanding of science concepts provide very useful information on the semantic aspects of understanding. For example, concept mapping delineates semantic propositions related to a specific topic. According to Novak and Gowin (1984):

> ...concept maps are intended to represent meaningful relationships between concepts in the form of propositions. Propositions are two or more concept labels linked by words in a semantic unit.... A concept map is a schematic device for representing a set of concept meanings embedded in a framework of propositions. (p. 15)

The exercise of constructing concept maps is a powerful one in terms of working through the detailed semantic relationships between propositions. However, such maps only show part of the 'territory', part of children's understandings. Other non-semantic, non-propositional aspects of understanding can have at least an equal impact on the construction of meaningful understanding. Emotions–values–aesthetics, interpretive frameworks, personal experiences and metaphors can greatly influence the way inferences are made, as well as the nature and character of one's understanding (Bloom 1992b).

The fundamental concern in carrying out science instruction is to ground science (knowledge, methods and beliefs) in appropriate contexts. From a context of meaning perspective, the grounding of particular student-generated explanations or ideas in appropriate contexts involves identifying the particular perspective or context in which the explanations and ideas fit. This process is followed by assessing the validity of how well these explanations and ideas fit within the particular context. For example, a young child in a previous study (Bloom 1990) claimed that the hole in the front of an earthworm was for putting through a hook. Such a claim is not valid within the context of biology, but is appropriate within a context of human use, namely fishing. The claim may also be appropriate within a context of story-telling. The notion of grounding science instruction in appropriate contexts has been described by other researchers. Duschl *et al.* (1990) have provided an overview of four such contexts. The context of justification is concerned with justifying knowledge claims in a historical framework, which falls within the scope of normal science. The context of discovery is concerned with developing theoretical knowledge claims in a historical framework of competing claims, which falls within the scope of revolutionary science. The context of future

use and the context of use place knowledge within the scope of how students may use the information in a future situation and how they are using the information in specific tasks (Bransford *et al.* 1986 [June], cited in Duschl *et al.* 1990). Bateson (1979) discussed three types of contexts in terms of the nature of the relations involved in how we define and understand phenomena. His notion of spatial context defines nose by its location and function. A temporal context describes nose by its use within a particular sequence of events and interactions. Finally, from a formal context, nose is defined from an embryological perspective.

The notion of context is also discussed by Rosch (1978), in terms of the principles of categorization, which relate to levels of categorization and to prototypes. She sees both the vertical aspect of subordinate, basic and superordinate levels and the horizontal aspect of prototypes as theories of context. The vertical aspect deals with levels of abstraction. The particular context determines the level of abstraction to be used. In general, the basic level 'is appropriate for using, thinking about, and naming an object in most situations in which the object occurs' (p. 43). She also considers scripts, events and basic-level categories to be equivalent and context bound. The horizontal aspect of prototypes deals with the nature and internal structure of categories. Prototype in this sense is an example or image that contains attributes or characteristics which typify the category. For example, 'robin' or an image of bird that looks like a robin may be the prototype for a particular individual. In Rosch's view, context determines which prototypes and objects are relevant. Such a perspective of the cognitive context has a fundamental and hierarchical organization punctuated by prototypical exemplars. The hierarchical view is not that different from Bateson's (1979) discussion of classification and process where the hierarchy is established by 'a *zigzag ladder of dialectic between form and process*' (p. 215, emphasis in original). The notion of prototypes is also discussed by Bateson as context markers and by Bruner (1986) as triggers.

From each perspective of context, the fundamental point is that context provides meaning. No action, event or object has meaning separate from some context. All understandings, actions, events and objects occur within one or more sociocultural contexts, as well. As Bruner (1990) contends, 'meaning grows out of use...' and 'cultural contexts are always contexts of practice...' (p. 118). In terms of science learning, White (1988) suggests that cultural contexts influence thinking in ways that create differing conceptual constructions and that these different constructions 'are not wrong...'; it is just that 'concepts are invented and...mean different things to different people' (p. x).

If we want to gain a more complete understanding of how children construct knowledge and create meaning and how we can help them to understand the contextual dependency of knowledge and make use of knowledge within a variety of contexts, then we need to explore ways of tapping into the non-semantic aspects of cognition and of revealing their contexts of meaning. Informal interviews, as used in previous studies (Bloom 1990a, b, 1992a, b), are an important, but time consuming, means of assessing student understandings. Many other approaches can be used to expose students' understandings and context of meaning. Context mapping as employed in the present study is one such method. Although context mapping provides some data on semantic relations, the present paper pays particular attention to the utility of such a method for extending the range of relevant information, including (*a*) personal experiences, (*b*) metaphors,

(*c*) interpretive frameworks, (*d*) emotions–values–aesthetics, and (*e*) other general features of the nature of contexts of meaning.

Method

Twenty-four fifth-grade students were selected to participate in the present study. The students came from predominantly middle-class neighbourhoods in a small city in eastern Ontario. Thirteen of the students were girls and 11 were boys. All 24 students (with one exception due to an absence) participated in a variety of data collection tasks. The present paper, however, focuses on one type of task, which is referred to as context mapping. All of the students have been assigned pseudonyms beginning with the letter 'E', which corresponds to the grade level (fifth letter of the alphabet for fifth grade; in addition, female pseudonyms refer to female students and vice versa).

The methodological technique discussed in the present paper is one of seven used over a period of four months (March to June). The first task the students completed was a context map on 'issues facing the world'. Five weeks later, the second context map on 'forests' was completed. Each context mapping activity lasted for about 40 minutes, which allowed enough time for all children to work through the task at their own pace.

Prior to beginning this task, instructions were given on how to construct a context map. These instructions stated that they should brainstorm and write down as many ideas as they could think of about the topic in the centre of the page. The ideas should be connected to the central word by a line. After they completed listing their ideas, they were told to look for ideas that were related in some way and connect these ideas with lines, and label these connections. In order to clarify these instructions, the class worked as a group through an example context map on 'school'. I wrote the word 'school' on the chalkboard and added the children's ideas to the map. After about five minutes, I asked them to look for ideas that could be related or linked. As they identified such links, I asked them to come up with a descriptive label for the link. The first label was a fairly obvious connection, something on the level of 'maths' and 'work' with the label, 'maths is work'. After this first label was completed, I suggested they look for links between ideas that might be quite different from each other. After this, another link suggested a relationship between 'boring' and 'teacher' with the label, 'teachers are boring'.

Following these instructions, 13″ × 20″ sheets of paper and three fine-tip markers (red, blue and black) were distributed to each child (some children used their own markers). They were told to write 'issues facing the world', in the centre of their paper. The children were asked if they understood what this meant and were asked to define 'issues'. One child said, 'problem', and another offered an example, 'pollution'. Others were ready to come up with more examples, but I explained that I was interested in each of their own ideas and that we should not share too much at this point. I emphasized this point again, asking them not to talk to each other or look at each other's work until the tasks were complete. Part-way through their work on the task, I reminded them to try making links between some of their ideas.

For the second context map on 'forests', no formal instructions were given. I asked them if they remembered how to do context maps, passed out the sheets of paper and markers, and proceeded with the task. Prior to giving them the topic

word, I reminded them to do their own work and not talk to each other or look at each other's papers. Part-way through the task, I reminded them to try to link ideas and label them.

During both of these sessions, my graduate research assistant was present and helped to field individual questions as the children worked. Following a preliminary analysis of each set of context maps, interviews were conducted to clarify specific items included on the context maps of selected students (10 students were interviewed individually during follow-up sessions). Children were selected for the follow-up interviews based on questions we had about unusual items in their maps. The research assistant also conducted the follow-up interviews with the children. The interviews were limited to the specific questions we had about the content of their maps. Each of the follow-up interviews was tape-recorded and transcribed by the research assistant.

As far as I know, the children had not formally studied world issues or forests. They certainly had not done so during that current school year. Since there is a fairly steady turnover of both teachers and children in this school and school board, it is difficult to know what took place in previous years (teachers are required to change schools every five years). Furthermore, there is no set curriculum. Teachers pretty much decide what they are going to teach each year. In terms of children's prior experience with using diagrammatic representations, such as concept maps or webbing, it is again difficult to determine. Their current teacher did not use such techniques. However, some teachers in the research site school, as well as other schools, occasionally use a technique called 'webbing'. Webbing is similar to context mapping in form, but it does not emphasize the linking of related ideas and it does emphasize semantic knowledge.

As with any task, contexts maps provide a glimpse of a child's thinking and knowledge. Any organization of the information included in the maps is of the students' own making. The follow-up interviews were an important means of gaining a more complete picture of the children's thinking. When looking at the data from the context maps and interviews, it is important to realize that the typological categories of contexts of meaning are not necessarily mutually exclusive. A metaphor obviously fits into the 'metaphor' typological category, but it can also fall within an emotions–values–aesthetics framework or within an anthropomorphic interpretive framework. Although such overlap may be of concern from the perspective of instrument validity, the nature of human cognition does not provide neatly packaged differentiations. This overlap and interrelatedness is part of the power of this wider sense of cognitive context of contexts of meaning. More details on how these various contextual components affect one another is described in Bloom (1992b).

Results

The difficulty in discussing the data in the present paper lies in the perspective being taken. This paper does not use the data to establish or embellish the theoretical framework of contexts of meaning. Rather the data are used to evaluate the effectiveness of a methodological technique in eliciting data relevant to contexts of meaning. The reader may find the previous articles on this topic useful in providing a more detailed description of the framework (Bloom 1990a, b, 1992a, b).

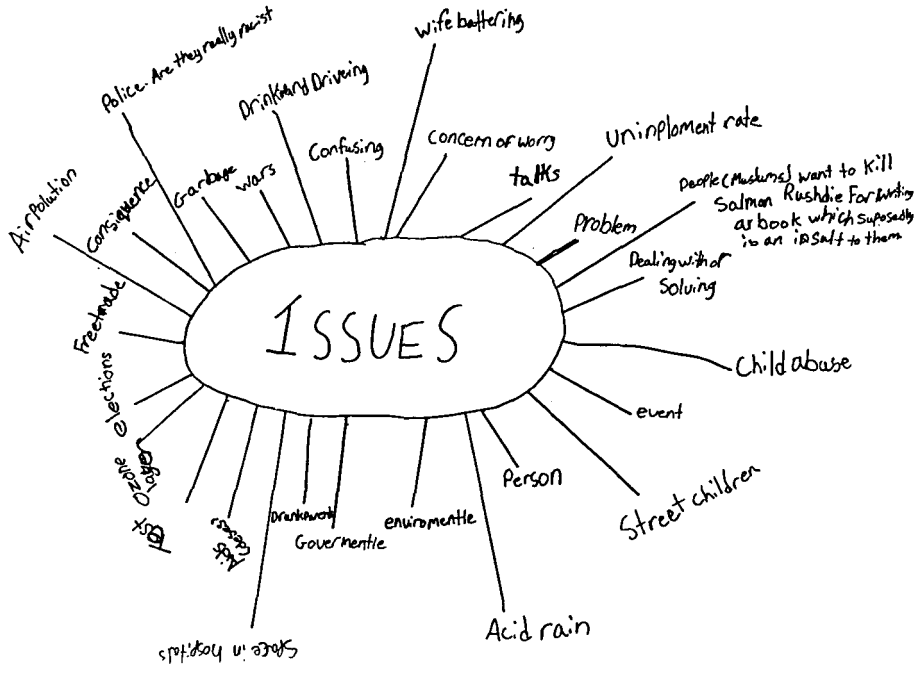

Figure 1. Organization of Emily's context map of issues facing the world: her 'levels' of organization are related to each item's distance from the centre.

The discussion of the methodology will begin with general features, followed by discussions of semantic knowledge, interpretative frameworks and emotions–values–aesthetics. Since personal experiences and metaphors in the data tend to be embedded in or strongly associated with the other typological components of context of meaning, they will be discussed along with these other categories. A compilation of the data from all context maps appears in the tables in Appendices A–D.

General features

As discussed previously, context maps impose minimal organization and structure. Any organizational scheme evident in the context maps is a function of the student. As it turns out, most maps show no explicit organizational structure. One exception is Emily's context map of issues facing the world (see figure 1). Visual inspection of her map shows no apparent organization. However, during a follow-up interview she explains (in her own words) that:

> ...the issues were broken into several levels. At the first level are *symptoms* of problems, words like 'problem', 'event'. At the second level are words pertaining to *consequences of actions*, words like 'election' and 'drinking and driving'. The third level is *issues, current events*. (emphasis added)

Each of her 'levels' corresponds to each item's distance from the centre. The only other explicit organizational structure in the context maps appears in Earl's issues

Table 1. Categories of items on forest context maps and their frequencies of occurrence.

	Subcategory		*Total category*	
Item	*No.*	*%*	*No.*	*%*
Environmental features			231	62·6
Kinds of plants	67	18·2		
Animals	52	14·1		
Physical features	46	12·5		
Parts of plants	34	9·2		
Climatic features	13	3·5		
Seasonal features	10	2·7		
General descriptions	9	2·4		
Recreational and human use features			40	10·8
Environmental conservation issues			27	7·3
Emotional and sensory/aesthetic aspects			27	7·3
Biological concept features			20	5·4
Industrial, economic and forest product features			16	4·3
Other			6	1·6
Effects on humans			2	0·5
Total			369	99·8

context map. In this particular map, the relational links provide a conceptual organization, in which money is linked to five other items. In a follow-up interview, Earl explains:

> I guess that's what people think makes the world go round...the homeless need money, you need money to pay taxes, you need money to pay for nuclear power, money to pay for stuff, money to save the environment....

Both Emily's and Earl's context maps show a basic conceptual framework for organizing their ideas.

Semantic knowledge and relational links

When considering the usefulness of context maps in generating data relevant to contexts of meaning, it appears, in general, that the definitive discrimination between each typological category is difficult. This difficulty can be, in part, attributed to the fact that the task itself is semantic in nature. Since context maps require subjects to write down their ideas, the results take on the form of semantic knowledge and relations. The task of the researcher becomes an inferential one of using the information in the context maps as pointers to other processes and to the influence of other typological components.

The first and most obvious typological component evident in the maps is semantic knowledge. Within the semantic component, the categorization of specific items reveals interesting patterns in: (*a*) how frequently specific items or ideas occur across a group of students, (*b*) the nature of the ideas, (*c*) the relations evident in the links between items, and (*d*) potential alternative and weak conceptions.

The clustering and frequency of items on context maps reveal some of the more common exemplars in much the same way as word-association tasks, which reveal

information on levels of categorization (see earlier discussion of Rosch's basic level, etc.). For example (see table 1), over 60% of the items in the forest context maps are descriptive of the environment. Such descriptions frequently involve examples of the kinds of natural objects one might find in a forest. Almost 11% of the responses relate to recreational human uses. Over 7% include conversation issues, such as acid rain, pollution, poachers, fires and over-population. Over 5% of the items involve more complex conceptual descriptions, such as food chains, hibernation, habitat and predators. Over 4% involve items related to industrial, economic and forest product features, such as wood, lumber mills and paper. The categories themselves reveal a range of typicalities (how frequently specific items appear across individuals). For instance, features of the environment are more typical of the responses than are industrial, economic and forest product features. Ranges of frequency of occurrence also occur among subcategories and among the specific items. For example, under the environment category animal, plant and physical feature exemplars are more common or typical than climatic and seasonal features or other more general descriptions. Within the animal subcategory the two most typical components are 'animal', mentioned 19 times (out of 24 students), and 'bird', mentioned 12 times. The least typical exemplars include specific animals, such as grasshopper, squirrel, snake and wolf, each of which is only mentioned once.

The nature of the ideas or components of the map can be viewed globally in a cognitive context or more specifically as individual items in the typology. In figures 2 and 3, two context maps of forests can be compared. Eugenie's map (figure 2) is very simple with only four items, all of which are environmental features. Elise's more complex map (figure 3) with 18 items contains environmental features, as well as recreational and other anthropocentric features, biological concept features and environmental conservation issues. In Eugenie's map there are no links, while in Elise's there are 12 links. The overall view of the maps shows an obvious difference in complexity. While the items in Eugenie's maps are concrete descriptions, Elise's items contain more abstract concepts, such as food chains, and several conservation issues, such as extinction, oil and garbage.

When links between items are present and labelled, they provide a further perspective of an individual's understanding in terms of contextual interrelations. However, not all students linked the items on their context maps, and not all of those who drew in links labelled them. Unlabelled links point to potential relational understandings, but claims about the meaning of such links are not warranted because of the high-level inferences required to assign meaning. What the links do provide is a focus for interview questions that can probe their meaning. Labelled links, on the other hand, allow the researcher or teacher to view how individuals understand some of the contextual relations.

Some examples of the types of relations evident from labelled links on the forest context map are listed in table 2. The complexity and abstractness of the relations vary among students. Some students organize the relations around a particular theme. As mentioned previously, Earl labelled six relations on his issues context map (linked items are followed by the label in quotes): (*a*) money to environment, 'money to pay to preserve it'; (*b*) money to garbage, 'pay for garbage'; (*c*) money to homeless, 'money to buy homes'; (*d*) money to nuclear war, 'money to pay for it'; (*e*) money to poor, 'money to feed the poor'; and (*f*) money to taxes, 'money to pay

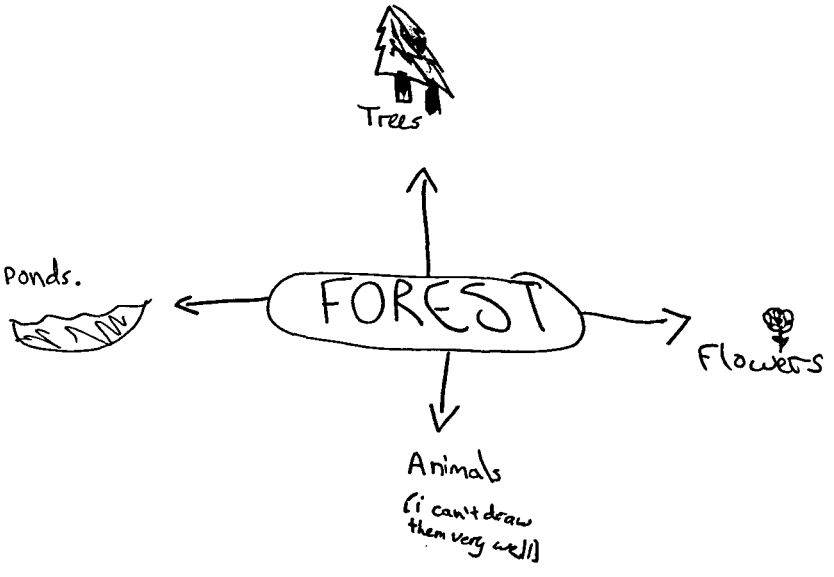

Figure 2. Eugenie's simplistic context map of forests.

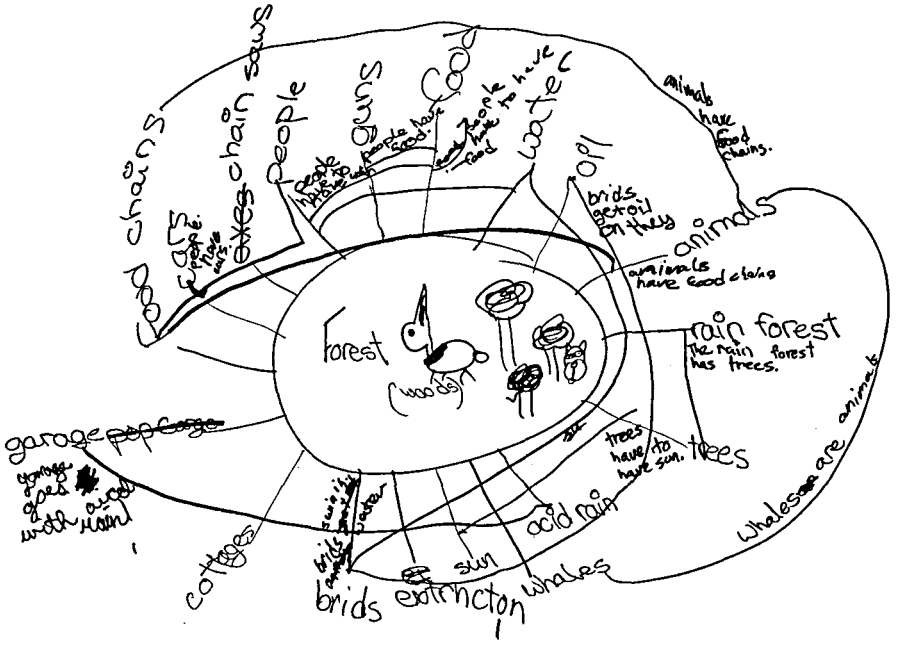

Figure 3. Elise's more complex context map of forests.

Table 2. Examples of relations evident among the labelled links on the forest context maps.

Relation	*Link*	*Label*
Causal	acid rain–trees	'trees get killed by acid rain'
	damp–mud	'after rain'
Spatial	animals–trees	animals 'live in' trees
	flowers–grass	flowers 'grow in' grass
Temporal	seasons–weather	'different weather for seasons'
	seasons–birds	'birds come in different seasons'
Requisite	people–food	'people have to have food'
	trees–sun	'trees have to have sun'
Classificatory	animals–grasshopper	'they are both animals'
	vines–greens	'are plants'
Attributional	leaves–moss	'both soft'
	wood–rocks	'they are both hard'

taxes'. Earl's context map demonstrates a natural organization of abstract relations. Such a high level of abstractness and organization was rare among the 24 grade 5 students.

Relational knowledge does not always appear as links. For example, several items with elaborated relations appear in Elise's context map of issues (each item is also accompanied by an illustration): (*a*) 'oil spills kill birds'; (*b*) 'pollution [picture of factory with smoke stack] → air turns to rain → acid rain goes to lakes → fishes die'; and (*c*) 'ash from garbage, shipped to the ocean and spills'. The relations that occur as labelled links or within items provide an important perspective on the complexity and substance of children's meaning.

At this point in the development of this data collection technique, the lack of links or other relational evidence does not mean that children do not understand any relations. Rather, it may be that by the time they get around to adding links, they are tired of the task and just do not bother constructing the links. Others may find the task of labelling links overwhelming. For instance, at the end of the forest context map session, Elton drew a circle around his map and said, 'they're all connected'. The overwhelming amount of information available may make the context mapping tasks more difficult for some children. It is interesting to note that on his first attempt at context mapping (issues), Elton listed three items and gave up. He looked completely frustrated by the task. However, on the forest map he listed 30 items. After doing several of the other tasks that followed the first task (issues context map), Elton may have felt more relaxed and more confident with the research project when the forest context map was presented.

The final aspect of semantic knowledge concerns potential alternative and weak conceptions. Although such conceptions may not be very elaborate on the context map itself, certain items point to areas in need of further exploration. Examples that point to alternative or weak conceptions from the forest context maps are evident in the labelled relations between the items: (*a*) 'both [leaves and flowers] *attached to bark*', (*b*) 'animals *become* extinct', and (*c*) 'animals *have* food chains' (emphasis added). Unlabelled relations are more difficult to recognize as pointers to vague or alternative conceptions; however, a couple examples from the forest maps are, (*a*) slugs to insects and (*b*) forest fires to pollution.

Interpretive frameworks

Interpretive frameworks appear to be alluded to in the students' choices of what to include in their context maps. For instance, items that concern human needs and desires, such as recreational and industrial uses of forests, may be connected with an anthropocentric framework. Two children's context maps point to other personal interpretive frameworks. For example, two rather different issues context maps were created: (*a*) Elizabeth's focused on 'musicals' and (*b*) Evelyn's focused on 'summer'. Both of these maps seem completely out of place. When both children were asked about their maps, they responded in similar ways. Elizabeth said that everything was related to musicals because she 'loves acting'. Evelyn said that she liked it 'when the weather is warm'. When asked again about issues, Elizabeth mentioned rain forests and acid rain and Evelyn specified only pollution. The issues other students listed were not as important to these two girls as were their own personal areas of interest. What Elizabeth interpreted as issues involved singing, speaking, scripts, applause and so forth. Evelyn's issues centred around wearing flip-flops and shorts, swimming and so forth.

Emotions–values–aesthetics

Evidence for emotions–values–aesthetics (EVAs) is found within the context maps of certain individuals. Ella's forest context map contains a number of EVAs, such as 'dangerous', 'scary', 'nothing', 'no stores', 'dark' and 'no one (alone)'. These six items are among a total of 13. In addition, 'no stores' and 'no garbage cans' could fit into what appears to be a very unpleasant view of forests. 'Wolves', although not linked to any other item, appears just below scary and dangerous on her map. In a follow-up interview, Ella told of growing up on another continent and that in the jungles

> ...there are these people who like to wear masks and come through the grass and scare you. They wear masks just to scare you. Like they chase you. I don't know why they do that. Like sometimes they steal, sometimes they'll catch you and take you to, I don't know.... They'll kill you sometimes and steal all your things and run away....

She went on to describe how she went back to visit a friend who tried to scare her with a mask. Her emotional view of forests appears to be based in some frightening experiences earlier in her childhood. In her issues context map, Ella includes 'exhausted', 'sad' and 'worrying' along with three conversation issue items. 'Exhausted' and 'sad' are linked with no label. In her case, a consistent pattern of EVAs appears to influence her thinking.

Emily's forest context map contains a different assortment of EVAs. Out of 20 items, the following appear to be connected with EVAs: (*a*) five items are colours ('green, brown, golden, orange, red'); (*b*) 'clean air', 'quiet'; and (*c*) 'peaceful'. In addition, three other items include elaborated descriptions of potential perceptions: (*a*) 'tree roots sticking out of the ground', (*b*) 'animal tracks by a pine tree in the snow', and (*c*) 'owl's call'. Each of these items appears to have a more metaphoric and poetic perspective, especially when seen in conjunction with the other EVA-related items. Here, again, 50% of the items are related to emotions–values–aesthetics. In contrast with Ella, Emily's view is inviting. Other children's maps contained items or labels making value judgements, such as Erica's labelling of the link between 'drugs' and 'drinking and driving' as 'both not good'. The point

is that the thinking about and the meaning associated with the context map topics is influenced by very personal emotions–values–aesthetics.

A majority of the information included in context maps is semantic in nature. Depending on the child, a certain proportion of this information may be rooted in personal experience or episodic knowledge. In either case, the information varies in its complexity, elaboration, organization and so forth. In general, context maps tend to be more superficial than concept maps. However, the advantages of context maps appears to be in their (*a*) generality, (*b*) allowance for freedom of expression, and (*c*) inclusion of a wider variety of information. Although context maps may lack detailed information on specific concepts, they can serve as a basis for follow-up interviews or other tasks that probe into specific details.

Discussion

The notion of contexts of meaning was originally formulated during the analysis of data from informal interviews that focused on children's free exploration of particular objects and phenomena. The free exploration in such informal interviews allows children to express themselves more openly. Although the presence of the researcher certainly influences what children do and talk about, interviews of this sort provide a view that more closely approximates natural cognition. Metaphors evident in conversations are not forced; emotional reactions are not artificially stimulated. What arises in the children's conversations does so naturally.

By comparison, the two data collection strategies used in the present study impose some limits on the way children express themselves. Context maps are written tasks and tend to be semantic in nature. Within this constraint, however, the task places very little restriction on what is included and how it is represented and organized. Many children took the liberty to illustrate their context maps. Such illustrations represent non-semantic understandings. In addition, such visual images often relate to or contain metaphors (Bloom 1990b), emotions–values–aesthetics, and so forth. The results of these tasks depict each child's personal construction. Nevertheless, extensive claims are best made in conjunction with one or more other data source. As mentioned in the results section, follow-up interviews based on items in context maps are very useful.

Context maps tend to show general patterns of understanding around a specific topic. For the most part, specific conceptual details are not evident in context maps. However, general features and conceptual descriptors are included. When included, links between items explicitly or implicitly depict relations between these features and concepts. Context maps do appear to expand on Rosch's (1978) notion of context. They provide data on the vertical component of levels of abstraction from superordinate level to basic level to subordinate level categories. For example, in Emily's context map of issues (see figure 1), 'people...want to kill Salmon Rushdie' is a subordinate-level example of an event, 'air pollution' is an example of a basic-level category, and 'environmentle issue is an example of a superordinate-level category. In terms of the horizontal component of prototypes and other features, context maps point to, if they do not include, prototypes and contain a wide variety of featural components that help to establish context. Featural components include semantic as well as other, non-semantic components. Prototypes are pointed to by certain basic and superordinate level terms, such as bird.

For example, Elise's context map (figure 3) mentions 'brids' [sic, for birds] and also includes a drawing of her prototypical bird in the centre.

At this point, I am hesitant to assert that the differences between context maps are due necessarily to individual differences in cognitive ability, knowledge or other aspects of cognition. Some individuals include a variety of emotional and aesthetic items, while others do not. A few maps contain predominantly concrete descriptive features, whereas others delineate more abstract concepts. Some students list large numbers of items and others include only a few. Several maps contain explicitly linked relations and many other maps contain no links at all. Can such differences be attributed to individual characteristics? Obviously, some of the variation is due to individual differences, but to what extent are such differences an artifact of the task? Does Eugenie, who listed only four concrete features of forests on her forest context map, have a very limited knowledge of forests? Or was she tired of doing or turned off by context maps? Is writing viewed as a difficult chore? Claims about the extent of knowledge and the extent of personal contexts of meaning cannot be made without more data. Items that are included in context maps do exist, but the question is one of what is not included. The usefulness of context maps, therefore, lies in their delineation of general patterns which can act as pointers to aspects that can be explored in more detail through interviews or other data collection strategies.

The tendency when using context maps is to view the information contained within them as static. From the perspective of contexts of meaning, any information from interviews, context maps and other tasks is seen as undergoing constant change. Such information is not static. Another tendency of researchers is to view the contents as a complete description of an individual's perspective or understanding. Again, from the point of view of contexts of meaning, a particular individual can hold numerous and even conflicting perspectives or understandings. So, when we look at children's context maps and drawings, what we see is a glimpse of their personal contexts of meaning, but it may not be a complete picture.

In contrast with informal task-based interviews and context maps, most previous and current research in children's conceptions overlooks significant aspects of meaning. The underlying assumption that meaning is semantic focuses attention on semantic knowledge components. Concept maps, as described by Novak and Gowin (1984), focus on semantic knowledge. Sorting tasks, word association and tests similarly limit and focus the content on semantic knowledge. However, with context maps other aspects of cognition and understanding can be included.

Much of the research on children's conceptions in science has missed important facets of the construction of meaning. Although for the most part ignored by previous research, emotions–values–aesthetics, interpretive frameworks and personal experiences have considerable impact on the way children make inferences and construct knowledge (Bloom 1992b). The influence of such is not necessarily negative and is certainly a part of being human. In having such an impact, however, it is imperative that we begin to pay attention to the non-semantic components of knowing and to the wider context of meanings and the multiple perspectives or understandings they bring to bear. The utility of alternative methodological strategies in eliciting rich and elaborate data on various aspects of children's contexts of meaning is an important step in widening the scope of our comprehension of how children construct highly personal and meaningful understandings.

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Appendix A. Tally of all items listed on the issues context maps ($N = 24$, total items = 300; numerals refer to number of occurrences).

18 pollution ([1]–air (smoke) turns to rain –acid rain goes to lakes –fishes died)
16 garbage ([2] no place to put it–the garbage people use everyday)
13 acid rain ([1]–bad)
12 free trade
11 drug(s) ([1]–bad)
11 environment(al)
10 war(s)
7 ozone layer ([1]–is getting demolished)
6 jobs ([1]–not enough jobs)
5 homeless (people ([1]–without homes))
5 over-population ([2]–people–too many)
4 AIDS
4 diseases ([1]–AIDS)
4 endangered species
4 taxes
3 food ([1]–no food)
3 government(al)
3 landfill
3 Meech Lake (accord)
3 recycling
3 toxic waste
2 abortion(s)
2 Ben Johnson (scandal)
2 cancer
2 child abuse
2 children
2 drinking and driving
2 extinction
2 food chains ([1]–die; [1]–are breaking up all the time)
2 laws
2 money
2 nuclear power
2 peace
2 people without homes
2 poachers (-ing)
2 poor
2 rain forest(s)
2 sickness (-es)
2 water
2 world peace
1 a lot of people out of food and shelter
1 accidents
1 air pollution
1 alcohol
1 Amazon forest
1 animal killing
1 animal life
1 animal population
1 animals
1 apartheid
1 applause
1 ash from garbage shipped to the ocean and spills
1 atom(ic) bomb(s)
1 babies
1 bicycles
1 blue box–good
1 bombs
1 bringing water to Third World countries
1 chemicals
1 cigarettes
1 concern of worry
1 confusing
1 consequence
1 conserve
1 costumes
1 crime
1 dealing with or solving
1 death
1 directors
1 drinking water
1 drunk driving
1 drunk parents
1 earth gatherers died
1 education
1 elections
1 endangered animals
1 environmental dangers
1 event
1 exhausted
1 factory
1 fashion
1 fire
1 flip-flops
1 food waste
1 government scandal
1 health
1 housing
1 hunger
1 incinerators
1 Indian reserve
1 inflation
1 kids with no education
1 kids with no school to go to
1 lay offs
1 make-up
1 mid-air disasters
1 movies
1 murders
1 narses [narcotics?]
1 not enough school
1 nuclear war
1 oil spills ([1]–kill birds)
1 people (Muslims) want to kill Salmon Rushdie for writing a book which supposedly is an insult to them
1 people are dying from things we can't treat
1 people crimes
1 people without jobs
1 person
1 plastic
1 plastic bombing
1 plates [plants?]
1 PLO
1 poison in fish
1 police are they really racist
1 politics
1 pools
1 poverty
1 pressure
1 problem
1 racism
1 rape
1 red tide
1 rights
1 sad
1 safety
1 school–homework
1 scripts
1 shorts
1 singing
1 space in hospitals
1 speaking
1 species of plants and animals are dying
1 sports
1 stages
1 star wars
1 street children
1 swimsuits
1 swimming
1 talks
1 test
1 too crowded
1 too many animals being killed by sci. experiments
1 tornados
1 toxic ash
1 tropical rain forests being destroyed
1 unemployment rate
1 unnatural changes
1 waste
1 waste management
1 water pollution
1 where to put garbage
1 wife battering
1 women in the work force
1 world war 3
1 worrying

Appendix B. Tally of all links made by children on the issues context map (N = 11/23; total number of links = 60).

No.	*Item*	*to Item*	*Label*	*No.*	*Item*	*to Item*	*Label*
3	acid rain	pollution	acid rain is pollution	1	health	AIDS	
1	acid rain	water		1	housing	not enough jobs	over-population
1	chemicals	unnatural changes		1	incinerators	water pollution	
1	conserve	AIDS		1	jobs	laws	
1	costumes	make-up	make-up is used with costumes	1	jobs	factory	
1	directors	scripts	directors give scripts	1	money	environment	money to pay to preserve it
1	drugs	Ben Johnsonb scandal		1	money	garbage	money to pay for garbage
1	drugs	drinking and driving	both not good	1	money	homeless	money to buy homes
1	drugs	pressure		1	money	nuclear war	money to pay for it
1	education	drugs		1	money	poor	money to feed the poor
1	education	sports		1	money	taxes	money to pay taxes
1	environment	acid rain		1	nuclear power	unnatural changes	
1	environment	free trade		1	nuclear power	war	
1	environment	incinerators		1	over-population	not enough jobs	
1	environment	landfill		1	politics	laws	
1	environment	rain forests		1	pollution	factory	
1	environment	tornados		4	pollution	garbage	[1] pollution
1	environment	water pollution		1	pollution	recycling	
1	environmental dangers	animal population		1	pollution	water pollution	
1	environmental dangers	waste management		1	pressure	alcohol	
1	exhausted	sad		1	rape	murders	violence
1	flip-flops	swimsuits	you wear both...in the summer	1	sings	speaking	do them both with your mouth
2	free trade	government		1	swimming	swimsuits	use them and wear them in pool
1	free trade	laws		1	war	atomic bombs	
1	garbage	taxes		1	war	laws	
1	government	taxes		1	world war 3	star wars	

Appendix C. Tally of all items listed on the forest context maps (N = 23, total items = 367; numerals refer to number of occurrences).

19 animals	3 path(s)	1 campfire	1 little forest	1 reptiles
19 tree(s)	3 plants	1 campgrounds	1 log cabin	1 river
12 birds	3 sap	1 canals	1 lumber mills	1 roots
12 grass	3 stumps	1 carelessness	1 many trees	1 scary
9 flowers	2 brown	1 cars	1 maple leaves	1 seasons
9 leaves	2 cattails	1 chain saws	1 maple syrup	1 shrubs
8 mud	2 dirt	1 cities	1 monkeys	1 ski-doo
8 water	2 fall	1 clean air	1 no garbage cans	1 skiing
7 wolves	2 fish	1 clearings	1 no one (alone)	1 slugs
5 acid rain	2 food	1 crystal water	1 no store	1 small
5 clouds	2 food chains	1 damp	1 nothing	1 snakes
5 cottage(s)	2 green	1 dangerous	1 oil	1 snow
5 sun	2 hibernation	1 dead	1 oil spills in waters (lakes, ponds, brooks)	1 so people can look at forests
4 bark	2 housing	1 deciduous		
4 camping (out)	2 hunting	1 different kind of animals	1 orange	1 sounds
4 habitat	2 insects	1 endangered species	1 outhouse	1 sparkling in winter
4 hunters	2 poachers	1 evergreens	1 owl's call	1 spring
4 lake(s)	2 rain forest	1 extinct animals	1 paper	1 squirrels
4 nature	2 vines	1 falling leaves	1 papers	1 stem
4 pine(s) (trees)	2 winter	1 fishing	1 parks–water, trees, path, map	1 stick
4 poison ivy	1 animal holes	1 food shortage		1 streams
4 pollution	1 animal shortage	1 food storage	1 peaceful	1 summer camp
4 ponds	1 animal tracks by a pine tree in the snow	1 food stored	1 people	1 sunny
4 rock(s)		1 forest fires	1 people going for walks	1 thistles
4 summer	1 animals live in trees	1 foxes	1 pine needles	1 tree roots sticking out of the grass
4 swamp	1 bears	1 garbage	1 planks	
3 branch(es)	1 berries	1 golden	1 poaching	1 trunks
3 bushes	1 bites	1 goldenrod	1 predators	1 twigs
3 colour(s)	1 blood	1 grasshopper	1 puddles	1 warm
3 dark	1 boating	1 greens	1 quicksand	1 waterfalls
3 deer	1 bogs	1 guns	1 quiet	1 weather
3 extinction	1 bristles	1 hikes	1 rabbits	1 wet
3 fire(s)	1 brooks	1 ice	1 raccoons	1 whales
3 moss	1 buds	1 invaders	1 rain	1 wilderness
3 mountain(s)	1 bugs	1 large forest	1 rashes	1 wood chips
3 over-population	1 camp	1 last of trees (not enough)	1 red	

Appendix D. Tally of all links made by children on the forest context map (N = 14/24; total number of links = 120).

No.	*Item*	*to Item*	*Label*	*No.*	*Item*	*to Item*	*Label*
1	acid rain	carelessness		1	deer	leaves	
1	acid rain	fire		1	thistles	deer	
1	acid rain	garbage	garbage goes with acid rain	1	fire	food storage	
2	acid rain	pollution		1	fire	housing	
1	acid rain	trees	trees get killed by acid rain	1	fishing	camping	
1	acid rain	water		1	fishing	waterfalls	
1	animals	bears		1	flowers	grass	grow in
1	animals	birds		1	flowers	leaves	both attached to bark
1	animals	deer		1	flowers	thistles	
1	animals	extinction	animals become extinct	1	food chain	food	
2	animals	fish		1	food stored	over-population	
1	animals	food chains	animals have food chains	1	forest fires	carelessness	
1	animals	grasshopper	they are both animals	1	grass	dirt	grass grows from dirt
1	animals	hunting		1	grass	flowers	
1	animals	insects		1	grass	vines	
1	animals	monkeys		1	grasshopper	grass	grasshoppers sleep in the grass
2	animals	nature		1	hunters	invaders	they invade
1	animals	people		2	hunters	poachers	
1	animals	snakes		1	hunters	predators	
1	animals	trees	live in	1	hunting	animal shortage	
1	animals	whales	whales are animals	1	hunting	bears	
1	bites	fishing		1	hunting	deer	
1	bites	insects		2	lakes	ponds	
1	bushes	berries		1	leaves	moss	both soft
1	camping	campgrounds		1	mud	damp	after rain
1	camping	summer		1	mud	lakes	
1	cities	invaders	some invaders make cities	1	oil	birds	birds get oil on them

1	colours	animals		1	over-population	food shortage	
1	colours	nature		1	over-population	monkeys	
1	colours	trees		1	paper	planks	
1	colours	water		1	paper	trees	
1	paper	wood		1	trees	berries	
1	paper	wood chips		1	trees	branches	
1	people	cars	people have cars	2	trees	bushes	
1	people	food	people have to have food	1	trees	forest fires	
1	people	insects		1	trees	hibernation	some animals hibernate in trees
1	people	water	people have to have water	2	trees	leaves	[1] both from trees
1	pines	leaves		1	trees	planks	
1	pines	lumber mills		1	trees	plants	plants
1	plants	poison ivy	plants	2	trees	rain forest	the rain forest has trees
1	pollution	carelessness					trees die in the rain forest
1	pollution	forest fires		2	trees	stumps	
1	pollution	mud		1	trees	sun	trees have to have sun
1	pollution	oil spills		1	trees	twigs	
1	rash	goldenrod		3	trees	wood	[1] (wood) comes from (trees)
1	reptiles	nature		1	trees	wood chips	
1	rocks	waterfalls		1	vines	greens	are plants
1	seasons	birds	birds come in different seasons	1	water	birds	birds swim in water
1	seasons	weather	different weather for seasons	1	water	canals	
1	shrubs	flowers		1	water	dirt	
1	shrubs	goldrod		1	water	mud	
1	shrubs	thistles		1	wood	rocks	they are both hard
1	slugs	insects		1	wood	planks	
1	stumps	twigs		1	wood	wood chips	
1	trees	bark	(bark) is on (trees)	1	wood chips	planks	