

# Children's Representations of Taxonomic Categories for Application in a Web Portal: An Exploratory Study

**Abstract:** This paper presents an exploratory study of four children who were asked to use concept-mapping techniques to arrange 60 concepts in a hierarchical taxonomy. It represents a step towards better understanding children's categorization in order more effectively to construct taxonomic subject directories for use by children on the Web.

**Résumé :** Cette communication présente une étude exploratoire effectuée auprès de quatre enfants à qui on a demandé d'utiliser les techniques de correspondance conceptuelle pour organiser 60 concepts en une taxinomique hiérarchique. Ceci représente la première étape vers une meilleure compréhension de la catégorisation des enfants, afin de construire un répertoire taxinomique de sujets plus efficace utilisé par les enfants sur le web.

## 1. Introduction

Elementary school students regularly seek information from the Web. In so doing they often choose to browse hierarchically organized subject directories rather than to search by entering keywords. Our earlier research suggests, however, that students will only opt for browsing when they can easily determine at what point to enter the directory and at each subsequent node which direction to choose (Large, Beheshti, Nessel & Bowler, 2006). In this paper we report on a small-scale, exploratory study in which four children were asked to sort concepts into taxonomic categories. The primary objective was to determine whether their taxonomic structure resembled that which we had previously created for a web-based portal to be used by children

In winter 2003 we had worked with two intergenerational teams comprising three of the authors together with eight students from grade-six and six students from grade-three respectively. Over a number of sessions each team designed a low-tech prototype web portal to find information relating to Canadian history (Large, Beheshti, Nessel & Bowler, 2004). Both teams chose to incorporate in their portal a hierarchical subject directory as well as a keyword searching capability. From these two experiences emerged an intergenerational design methodology we have named "Bonded Design" (Large, Nessel, Beheshti & Bowler, 2006). Despite the active involvement of children in most aspects of the portals' design, the working versions of the two portals based on the low-tech prototypes included a hierarchical subject directory that was constructed by the researchers alone and incorporated into both portals. The question therefore arises as to whether the children would have designed a similar subject directory had they been given the task, or whether and how it might have differed? This paper seeks to respond to that question by reporting on a small-scale study to compare taxonomies created individually and then collectively by four children with that created by the researchers.

The hierarchical subject directory used in both portals grouped concepts into categories which were arranged in a taxonomic structure. This structure comprised eight top-level topics prominently displayed on the portals' homepage. From these main headings users could navigate through one to three subordinate levels depending on the topic. The structure, including all four levels, included around 1200 concepts. A sub-set of these

concepts selected from four of the topics provided the basis for the concept-mapping exercise.

## **2. Taxonomies**

The term “taxonomy” is derived from two Greek words, *taxis* meaning division or arrangement, and *nomos*, meaning law. Warner (2004) has defined taxonomy as a system of labels that form a hierarchical navigation scheme. Its distinctiveness lies in its emphasis on building intuitive structures and in employing labels that are familiar to users so that they can find information by browsing the structured hierarchies (Chaudhry & Jiun, 2005). The structure also means that information is located within contexts, or categories. Categorization is an integral part of the taxonomy development process (Chaudhry & Jiun, 2005). It “is the process of dividing the world into groups of entities whose members are in some way similar to each other” (Jacob, 2004). This categorization not only facilitates retrieval but also serves to clarify the meaning of concepts for users.

Simple categorization is a fundamental concept that children use to help them organize their thinking about the real world (Reys, Suydam & Lindquist, 1995). It allows children to understand that objects can be grouped in different ways. Children can be provided with a set of objects and then asked to group (categorize) them based on their thinking as to how the objects in each group might be the same. The basis for their understanding of this process is how things look to them (Platz, 2004). Young children tend to construct categories differently from adults (Clements, 2001) and therefore different categorizations might result from a child than an adult.

Researchers have identified several category types that children may use to categorize concepts (Nguyen & Murphy, 2003). Taxonomic categories organize concepts into hierarchies of increasingly abstract categories based upon common properties or similarity (such as a poodle as a subordinate category of “dogs”). These common properties allow a hierarchical structure in which more specific categories have all the properties of more general categories plus additional distinguishing properties. Thematic categories group concepts that are associated or have a complementary relationship and that often have a spatial or temporal contiguity (such as a horse and carriage, because the horse is used to move the carriage). Script categories are formed when items play the same role in a script – a schema for a routine event (for example, a horse and a bookmaker because they can both play a part in a racecourse schema).

It used to be thought that taxonomic categories were the only “correct” form of categorization (see, for example, Inhelder & Piaget, 1964) and that young children could not master this technique, instead grouping concepts using only thematic or script categories. More recent studies, however, have found that adults also use thematic and script categories when the relations are sufficiently strong (Lin & Murphy, 2001; Murphy, 2001) and that children can apply taxonomic categories (Nguyen & Murphy, 2003). In fact, striking similarities have been found between the conceptual structures of adults and children (Livingston & Andrews, 2005).

One methodology that has been used to explore how individuals construct and understand a taxonomic structure is concept mapping, which visually describes relationships between concepts in a knowledge domain. Children have used concept mapping to group concepts according to their perceived characteristics, to assign names to the resulting categories so

that they reflect the children's mental representations, and to organize these categories into a taxonomy (see, for example, Novak, 1998). Concept maps provide a "picture" of how concepts in a domain are mentally organized or structured by students. Two techniques can be used to construct a concept map. In the "fill-in-the-map" technique students are given a concept map from which some of the concepts have been left out; the students must fill in these gaps. In the "construct-a-map-from-scratch" technique the students are given the concepts and then asked to construct a hierarchical or non-hierarchical map (Ruiz-Primo, Schultz, Li & Shavelson, 2001). In our study the latter technique was used to construct a hierarchical map.

Children seek information on the Web for educational and recreational purposes, and in so doing often exploit the browsing features of a hierarchical subject directory (Bilal, 1998, 2000, 2001; Large & Beheshti, 2000; Large, Beheshti & Moukdad, 1999; Schacter, Chung & Dorr, 1998). To browse the directory successfully, however, requires an understanding of the taxonomy employed to arrange categories so that a search for a given concept can be pursued through the various categorization levels until that concept is found. Borgman, Chignell and Valdez (1989) investigated children's ability to sort science concepts into categories. They found that children were able to categorize successfully as long as they understood the terms used. Cooper (2002) found that children could sort, group and categorize terms as well as provide labels for those categories.

Bilal and Wang (2005) were the first researchers to investigate whether the hierarchical design of web directories matched children's conceptual representations. They asked 11 students in grade seven to represent with concept maps concepts selected from two children's web portals: KidsClick! And Yahoo!igans! They found that the children encountered more problems with abstract than concrete concepts, that none of the children's maps were identical and that none matched the structure in either of the portal directories. They concluded, "directories that are designed for children should model cognitive structures into the system and incorporate different situations to accommodate children's traversal behavior and information needs."

### **3. Methodology**

#### **3.1 Concept selection**

The web portal created by the Bonded Design team has a subject directory comprising eight main topics: Aboriginals, Everyday Life, Government, People, Places, Science and Technology, Transport, and Wars. For the categorization study 60 concepts were selected, 15 each from four of the main topics: People, Places, Science and Technology, and Transport. We eliminated concepts that might be unknown to grade-five and grade-six students, such as from the People main topic the names of actual historical persons. A list of the 60 concepts is provided in Table 1. All of the concepts were chosen from the second level of the hierarchy. Each concept was handwritten on a white card measuring five inches by three inches.

An initial training session utilized 24 concepts belonging to six topics all related to "animals" (see Table 2). This subject area was selected both because the individual concepts were likely to be familiar to children and because their conventional classification by genus/species is also likely to be understood by this user group. This would help the children quickly grasp the concept of concept mapping based upon a taxonomic categorization. These concepts were handwritten on cards.

### 3.2 The Participants

Four girls volunteered for the study; two were from grade-five of elementary school and aged 11 years, and two were from grade-six and were 12 years' old. All had studied in their schools some aspects of Canadian history and felt at ease being asked to "sort cards" containing concepts drawn from this subject area. They also were all familiar with information retrieval from the Web. In this paper their names have been changed to Abby, Beth, Carol and Diane to protect their anonymity.

### 3.3 The location

The session took place in a very large empty room where the girls had plenty of space to lay out and arrange the concept cards on the floor.

### 3.4 Procedure

The session was attended by three researchers who began by discussing web portals with the girls, and the difference between searching with keywords and browsing through a hierarchically organized subject directory. The importance of a user-intuitive directory structure was explained and the concept mapping task about to be undertaken was situated in this context. The technique of concept mapping was briefly explained.

An initial training exercise was then conducted to familiarize the girls with arranging concepts into a concept map. Each girl was given an identical set of 24 cards each containing the name of an animal, but was not given the topic names, as she had to decide under which topics to place the concepts. For this purpose the girls were given some blank cards and marker pens so that they could create new cards to represent any super-ordinate levels including the top-level topics. The training session was timed and the final arrangements photographed (see Figure 1 for an example). The girls together with the researchers then walked around the four concept maps and discussed them – similarities, differences and any especially difficult decisions that had been taken. Their comments were noted by the researchers.

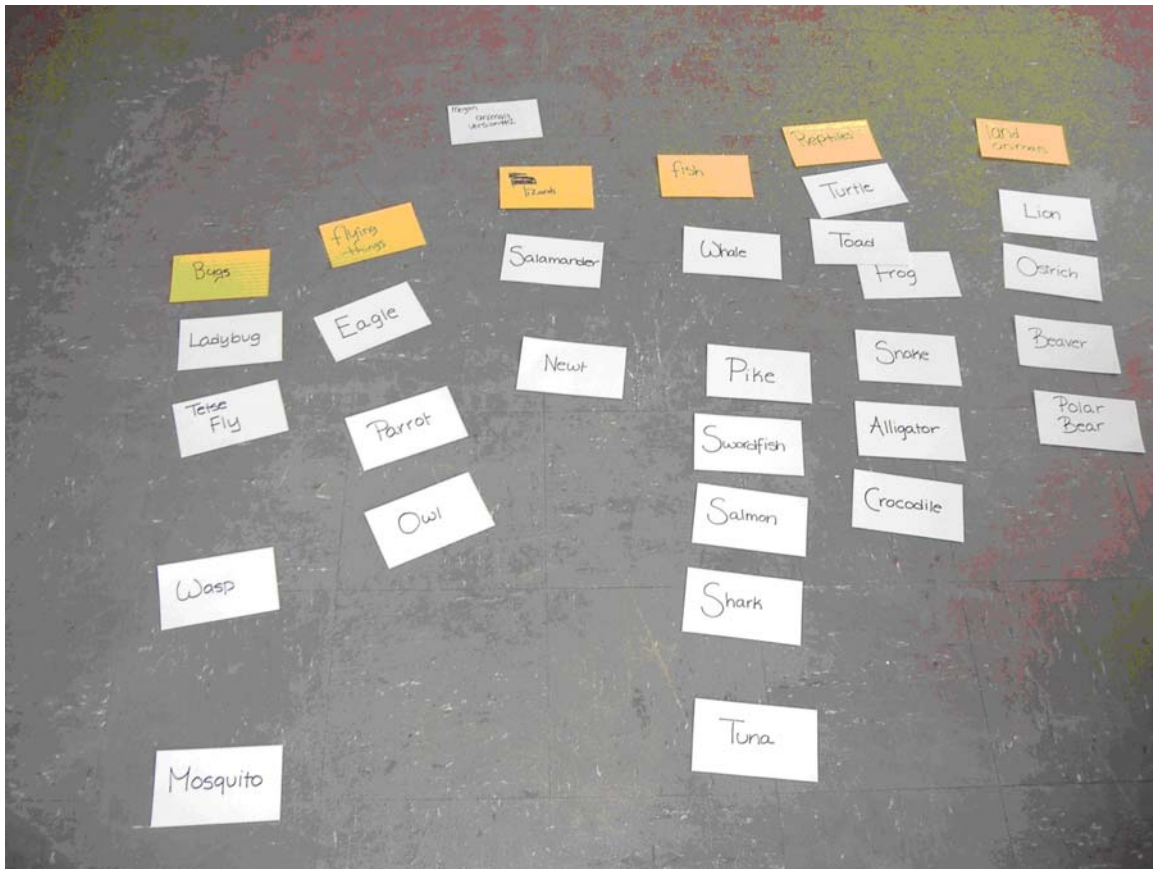
After this the girls were then ready to repeat this procedure with the 60 concept cards selected from the web portal subject directory. Again, they were not given the actual topics. The final stage of the procedure was for the four girls to work as a team and produce a new concept map which represented their combined opinions in the light of their individual experiences. This was discussed by all the girls and recorded by the researchers. The final step was to compare their directory with ours to identify similarities and differences in structure and topic and sub-topic labeling.

| Topic         | Concept                            | Topic                         | Concept                   |
|---------------|------------------------------------|-------------------------------|---------------------------|
| <b>People</b> | 1. Acadians                        | <b>Science and Technology</b> | 31. Agriculture           |
|               | 2. Actors                          |                               | 32. Archeology            |
|               | 3. Artists                         |                               | 33. Architecture          |
|               | 4. Chinese Canadians               |                               | 34. Astronomy             |
|               | 5. Coureurs de bois                |                               | 35. Biology               |
|               | 6. Doctors                         |                               | 36. Botany                |
|               | 7. Engineers                       |                               | 37. Chemistry             |
|               | 8. Explorers                       |                               | 38. Computer Sci          |
|               | 9. Journalists                     |                               | 39. Engineering           |
|               | 10. Musicians                      |                               | 40. Geology               |
|               | 11. Railway people                 |                               | 41. Mathematics           |
|               | 12. Ukrainian Canadians            |                               | 42. Medicine              |
|               | 13. Vietnamese Canadians           |                               | 43. Mining and Metallurgy |
|               | 14. Vikings                        |                               | 44. Oceanography          |
|               | 15. Women                          |                               | 45. Psychology            |
| <b>Places</b> | 16. Acadia                         | <b>Transport</b>              | 46. Airplanes             |
|               | 17. Alberta                        |                               | 47. Bicycles              |
|               | 18. Arctic                         |                               | 48. Boats                 |
|               | 19. Atlantic Canada                |                               | 49. Bridges               |
|               | 20. Lakes, Rivers, Canals and more |                               | 50. Buses                 |
|               | 21. Lower Canada                   |                               | 51. Caleches              |
|               | 22. Manitoba                       |                               | 52. Cars and trucks       |
|               | 23. Northwest Territories          |                               | 53. Horses                |
|               | 24. Ontario                        |                               | 54. Metro                 |
|               | 25. Quebec                         |                               | 55. Roads                 |
|               | 26. Rocky Mountains                |                               | 56. Sleds                 |
|               | 27. Rupert's Land                  |                               | 57. Snowmobiles           |
|               | 28. Upper Canada                   |                               | 58. Stagecoaches          |
|               | 29. Western Canada                 |                               | 59. Streetcars            |
|               | 30. Yukon                          |                               | 60. Trains                |

**Table 1. Sixty concepts from *History Trek Directory***

| Topic           | Concept       |                   | Concept        |
|-----------------|---------------|-------------------|----------------|
| <b>Fish</b>     | 1. Pike       | <b>Amphibians</b> | 13. Frog       |
|                 | 2. Salmon     |                   | 14. Newt       |
|                 | 3. Swordfish  |                   | 15. Salamander |
|                 | 4. Tuna       |                   | 16. Toad       |
| <b>Mammals</b>  | 5. Beaver     | <b>Birds</b>      | 17. Eagle      |
|                 | 6. Lion       |                   | 18. Ostrich    |
|                 | 7. Polar bear |                   | 19. Owl        |
|                 | 8. Whale      |                   | 20. Parrot     |
| <b>Reptiles</b> | 9. Alligator  | <b>Insects</b>    | 21. Ladybug    |
|                 | 10. Crocodile |                   | 22. Mosquito   |
|                 | 11. Snake     |                   | 23. Tsetse fly |
|                 | 12. Turtle    |                   | 24. Wasp       |

**Table 2. Twenty-four Training Concepts**



**Figure 1: Beth's Animal Taxonomy**

#### 4. Training Exercise

The primary purpose of the training session was to ensure that the girls understood how to construct a concept map from 60 concepts related to Canadian history. By choosing for training purposes a collection of animals with which they were generally familiar, and which would hopefully not be too demanding to assign to genus-species categories, the principles underlying concept mapping could be emphasized. This hope was largely fulfilled. One girl, Abby, replicated exactly our map without any problems and the other three girls all demonstrated an understanding of the process even though their maps deviated somewhat from ours. No-one took longer than 20 minutes to complete the task.

All four girls opted, as we had, for a two-level structure. They did this by dividing the 24 concepts into discrete categories and then assigning a super-ordinate name to each category. Nevertheless, the four concept maps generated differed one from another. In several cases these differences can be explained by incorrect assignment of animals to whatever categories had been created. For example, Beth did not correctly identify an ostrich as being a bird and classified a whale as a fish, while Carol also thought a whale to be a fish (Diane side-stepped this latter problem by including *Whale* along with various fish in a category labeled *Fish and other Sea Creatures*. In other words, the girls' knowledge of animals was insufficient occasionally to permit accurate categorization.

How did two of the girls tackle this exercise? In Carol's words, "I read all the cards and divided by fishes, birds, frogs and toads, like amphibians. I put all the insects in one pile, lizards, [and] mammals." Abby's rationale was more sophisticated: "I started by sorting

into their attributes and what they actually were. Those that didn't fit I put in piles of their own, like beaver, lion, [and] polar bear.”

### 5. History Concept Exercise

The 60 concepts had been selected from four of the main topics created by us for the web portal: People, Places, Science and Technology, and Transport. In our own taxonomy we had not inserted sub-topics between the main topic heading and the individual concepts related to it. In other words, our structure was heavy on breadth and light on depth. We took this decision because we thought it would be easier for users to navigate through the directory for a relatively small database that covers a wide variety of topics. They would only have to identify the main topic heading and then they would see all the subordinate terms displayed alphabetically. It was only rarely that another level was implemented (and this is not the case in any of our 60 selected terms). The price paid for adopting this approach was that users needed to work their way through what could be a long alphabetically arranged list of second-level terms, a task that young children find both laborious and error-prone. Would the children in our study adopt a different approach, employing greater depth and less breadth?

Abby chose five main topic headings (Table 3); the only difference from our main topic headings was the division of our *Science and Technology* heading into two: *Studies* and *Work*. Under *Work* she included not only three disciplines but also *Bridges* and *Roads* which we had included under *Transport*. When discussing her rationale, she explained that *Bridges* and *Roads* were the hardest to allocate to topic headings. She also subdivided *Places* into three sub-categories: *Provinces*, *Territories* and *Other*. The last sub-category she uses as a catch-all for a mixture of different concepts.

| Main Topic Heading | Intermediate Heading | Concepts  |
|--------------------|----------------------|---|
| Studies            |                      | Psychology, Astronomy, Geology, Biology, Chemistry, Computer Science, Mathematics, Oceanography, Architecture, Botany, Archeology, <i>Medicine</i>  |
| People             |                      | Chinese Canadians, Ukrainian Canadians, Vietnamese Canadians, Musicians, Explorers, Artists, Journalists, Doctors, Actors, Engineers, Vikings, Railway Men, Women, Coureurs de Bois, Acadians |
| Work               |                      | Mining & Metallurgy, Agriculture, Bridges, Roads, Engineering   |
| Transportation     |                      | Metro, Snowmobiles, Cars & Trucks, Horses, Trains, Buses, Airplanes, Boats, Stagecoaches, Bicycles, Sleds, Caleches, Streetcars   |
| Places             | Provinces            | Ontario, Quebec, Manitoba, Alberta  |
|                    | Territories          | Yukon, Northwest Territories  |
|                    | Other                | Rocky Mountains, Lakes, Rivers, Canals and more, Upper Canada, Lower Canada, Atlantic Canada, Western Canada, Arctic, Rupert's Land, Acadia   |

**Table 3: Abby's History Taxonomy**

Beth opted to organize the 60 concepts under nine topic headings (Table 4). She divided our main category, *Transport* into two: *Transporting Things* and *Transportation* based upon a logical presumption that means of transportation should be separated from transportation infrastructure. She divided our category, *People* into *Jobs*, *Gender*, and *Immigrants*. She chose to divide scientific and technical disciplines between two topic headings; all but one were categorized as *Things to Learn in School*, while medicine was given its own topic, *Things for Health*. In her own words, “I put *Study's* [sic] because it's what people study in school.” and “[The] two hardest [concepts] were *Medicine* and *Women*. I made separate categories for them, *Things for Health* and *Gender*.”

Carol chose eight topic headings for her taxonomy (Table 5). She divided *People* into two topic headings: *Working People of Canada* and *Different Kinds of Canadians*. When asked about this decision she replied, “Some are just plain old Canadians, others come from different places.” In terms of the concepts encompassed by our *Science and Technology* heading, she opted to include all but one under *Subjects*, leaving *medicine* as the sole concept within the catchall category, *Objects*, along with *Horses*. For her *Ways of Traveling* she included all of the concepts we had placed under the *Transport* heading, except for *Horses*. Finally, for *Places* she used three topic headings: *Bigger Parts of Canada* under which were placed concepts such as *Western Canada, Lakes, Mountains, etc.* and *Provinces and Cities and Towns*.

| Main Topic Heading        | Intermediate Heading | Concepts  |
|---------------------------|----------------------|---|
| Transporting Things       |                      | Bridges; Lakes, Rivers, Canals and More; Roads  |
| Transportation            |                      | Horses, Cars & trucks, Snowmobiles, Buses, Trains, Streetcars, Caleches, Boats, Airplanes, Bicycles, Metro, Sleds, Stagecoaches   |
| Jobs                      |                      | Coueurs de bois, Actors, Engineers, Railway Men, Artists, Journalists, Engineering, Explorers, Musicians, Doctors   |
| Things for Health         |                      | Medicine  |
| Things to Learn in School |                      | Computer science, Psychology, Astronomy, Geology, Biology, Mathematics, Agriculture, Chemistry  |
| Gender                    |                      | Women   |
| Immigrants                |                      | Acadians, Vikings, Vietnamese Canadians, Chinese Canadians, Ukrainian Canadians   |
| Study's [sic]             |                      | Archeology, Oceanography, Architecture, Mining and metallurgy, Botany   |
| Places in Canada          |                      | Acadia, Atlantic Canada, Yukon, Rupert's Land, Upper Canada, Manitoba, Ontario, Western Canada, Rocky Mountains, Lower Canada, Quebec, Northwest Territories, Arctic, Alberta |

**Table 4: Beth's History Taxonomy**

| Main Topic Heading             | Intermediate Heading | Concepts   |
|--------------------------------|----------------------|--|
| Subjects                       |                      | Mathematics, Biology, Mining and metallurgy, Archeology, Astronomy, Oceanography, Psychology, Engineering, Chemistry, Computer Science, Geology, Agriculture, Botany, Architecture |
| Objects                        |                      | Horses, Medicine   |
| Ways of Traveling              |                      | Airplanes, Roads, Bridges, Buses, Snowmobiles, Streetcars, Trains, Boats, Bicycles, Cars and Trucks, Caleches, Stagecoaches, Sleds, Metro  |
| Working People of Canada       |                      | Actors, Railway Men, Artists, Journalists, Explorers, Musicians, Doctors, Coureur de bois, Engineers   |
| Different Kinds of Canadians   |                      | Chinese Canadians, Women, Vietnamese Canadians, Acadians, Vikings, Ukrainian Canadians,  |
| Bigger Parts of Canada         |                      | Western Canada, Upper Canada, Lower Canada, Atlantic Canada, Arctic  |
| Lakes, Mountains, etc.         |                      | Lakes, Rivers, Canals and More; Rocky Mountains  |
| Provinces and Cities and Towns |                      | Northwest Territories, Alberta, Ontario, Rupert's Land, Manitoba, Acadia, Yukon, Quebec  |

**Table 5: Carole's History Taxonomy**



Diane, like Abby, used five topic headings (Table 6). She divided *Transportation* into two categories: *Things that help transport you and other things*, where she placed infrastructure together with *Horses*, and *Transportation* for vehicles of various kinds. As she explained, “I started by sorting *Transportation* ‘cause I thought it would be easiest”. “I had trouble with *Bridges, Roads*, so I made a separate category for them. *Transport* and *Places* was easiest, then *Studies, Jobs* and *People*.”

| Main Topic Heading                              | Intermediate Heading | Concepts   |
|---|----------------------|--|
| Transportation                                  |                      | Airplanes, Trains, Streetcars, Buses, Snowmobiles, Sleds, Boats, Caleches, Cars and Trucks, Bicycles, Metro, Stagecoaches  |
| Things that help transport you and other things |                      | Bridges; Roads; Lakes, Rivers, Canals, and More; Horses  |
| Studies and jobs                                |                      | Medicine, Botany, Mathematics, Mining and Metallurgy, Astronomy, Psychology, Oceanography, Agriculture, Architecture, Geology, Archeology, Engineering, Computer Science, Chemistry, Biology |
| People  |                      | Women, Acadians, Vikings, Railway Men, Vietnamese Canadians, Chinese Canadians, Coureur de bois, Ukrainian Canadians, Explorers, Musicians, Engineers, Actors, Doctors, Artists, Journalists |
| Places, Territories and Provinces               |                      | Arctic, Alberta, Atlantic Canada, Yukon, Western Canada, Upper Canada, Rupert’s Land, Rocky Mountains, Acadia, Manitoba, Lower Canada, Quebec, Ontario, Northwest Territories                |

**Table 6: Diane’s History Taxonomy**

For the final concept map (see Figure 2 and Table 7) the four girls collaborated after viewing and discussing each other’s concept maps. They assigned the concepts to four main topic headings but introduced in two cases intermediate headings: under the heading, *Transportation* were *Manners of Transportation* (vehicles) and *Things that Help the Transportation* (infrastructure); and *Places* was divided into four topic headings, *Provinces, Territories, Others/Unknown*, and *Parts of Canada*.

The girls completed the individual concept mapping task within 25 minutes and the group mapping exercise in 17 minutes.

## 6. Discussion

Both the training exercise and the main concept mapping task were accomplished by the four girls without great difficulty and in a relatively short period of time. They successfully sorted 60 concepts into categories to which they assigned names, and they assembled them into a hierarchical structure. The girls grasped the essence of relating concepts in a taxonomy rather than opting for alternative approaches. For example, none of the girls chose to link the concept, *Doctor* with *Medicine* or the concept *Railway Men* with *Trains* as they would if they had chosen to use thematic categories, where objects that are associated or have a complementary relationship are grouped. Similarly, none of them chose to link the concepts, *Explorers* and *Coueurs de bois* (fur traders) as they would if they had used script categories where concepts are grouped when they play the same role (but not complementary roles) in a script.



**Figure 2: Final Concept Map**

| Main Topic Heading                | Intermediate Heading   | Concepts   |
|-----------------------------------|--|--|
| Things you learn at school / Jobs |  | Chemistry, Oceanography, Archeology, Biology, Mathematics, Medicine, Architecture, Botany, Agriculture, Computer Science, Geology, Engineering, Psychology, Astronomy, Mining and Metallurgy |
| Transportation                    | <b>Manners of Transportation</b>                                 | Streetcars, Horses, Stagecoaches, Sleds, Metro, Buses, Airplanes, Snowmobiles, Caleches, Cars and Trucks, Bicycles, Boats, Trains  |
|                                   | <b>Things that help the transportation (bridges, roads, etc)</b> | Roads; Bridges; Lakes, Rivers, Canals and More   |
| People                            | <b>Workers and regular people</b>                                | Women, Railway Men, Artists, Journalists, Explorers, Musicians, Doctors, Coureurs de bois, Engineers, Actors   |
|                                   | <b>Immigrants</b>  | Chinese Canadians, Vietnamese Canadians, Acadians, Vikings, Ukrainian Canadians  |
| Places                            | <b>Provinces</b>   | Quebec, Manitoba, Ontario, Alberta   |
|                                   | <b>Territories</b>   | Yukon, Northwest Territories   |
|                                   | <b>Others/Unknown</b>  | Acadia, Rupert's Land, Rocky Mountains   |
|                                   | <b>Parts of Canada</b>   | Arctic, Upper Canada, Lower Canada, Western Canada, Atlantic Canada  |

**Table 7: History Taxonomy – Consensus**

The four concept maps, while sharing some similarities, did differ in both categorization and structure. However, after the experience gained in completing their own concept maps, discussing them, and then collaborating on a combined concept map, the girls produced in collaboration a hierarchical structure that was similar to the one constructed

by us. They opted, as we had, for four main topic headings and in three cases assigned virtually the same names. Only in the case of our *Science and Technology* topic heading did they deviate by calling it *Things you Learn at School/Jobs*.

The girls exhibited two interesting tendencies in their concept maps: a difficulty in encapsulating concepts within a concise heading, and a tendency to view the world based on their own limited experience (what might be termed a “small world view”). The first tendency is illustrated by topic headings such as *Things to Learn in School* and *Things that help Transport You and Other Things*. The second tendency is demonstrated in their perception of scientific and technical disciplines (as seen by us adults) as things studied in school and/or an occupation. In this case, however, there was one notable exception, the concept of medicine. Some of the girls struggled to place this concept, largely because they perceived it to mean a drug rather than a discipline (the word is, of course, a homonym representing these two different concepts). Within the context of 14 other concepts all relating to scientific or technical disciplines an adult might have assumed that a fifteenth concept, *Medicine*, should also be recognized as another discipline and categorized as such rather than interpreted as being a completely different concept that was unrelated to any other. A similar example is provided by the term, *Horses* which in the context of this concept mapping exercise might well have been considered a form of transportation, but in practice caused several of the girls problems in knowing where to assign it – and leading Carol to assign it to the main topic heading, *Objects* along with the term, *Medicine*, and Diane to include it with transportation infrastructure concepts such as bridges and roads rather than with means of transportation (such as airplanes and trains).

Their youth and general lack of life experience may have hindered the girls’ abilities to devise a more meaningful categorization. Categorization, according to its classical definition, is the “process of systematically dividing up the world of experience into a formalized and potentially hierarchical structure of categories, each of which is defined by a unique set of essential features. ...the membership within a particular category (extension) entails possession of the essential and defining character (intension) of the category” (Jacob, 2004, p.521). While this rigid view of categorization has been debated in the past, nevertheless, it may explain some of the problems encountered by the girls.

Unlike Bilal and Wang (2005), we did not find that the children encountered more problems with abstract than with concrete concepts. In fact, concrete concepts like *Horse* caused difficulties for several of the girls whereas more abstract concepts like *Archeology* seemingly did not trouble them. They also report that the children in their study (aged 11 to 13 compared with 11 to 12) based their categorization on perceptual, experiential and situational relationships rather than on conceptual relationships. There is some evidence of this phenomenon in our study, especially in the names assigned to some categories such as *Things you learn at school* which reflects the girls’ own view of their world rather than our categorization into the conventional category of *Science and Technology*.

In the combined concept mapping exercise the girls decided to introduce intermediate topic headings, clearly demonstrating their grasp of a hierarchical structure. In the individual exercise only one girl, Abby, had employed this technique but the others on seeing and discussing her approach, agreed that it improved the structure. After viewing Abby’s concept map, Beth said, “I put *Places*, because I wasn’t smart enough to put them under *Provinces and Territories*”. In our subject directory we had minimized the use of more than two hierarchical levels for fear that children would become disoriented when

navigating the structure. In this particular study we had deliberately opted to draw concepts from only the second level of the hierarchy. The division of the topic headings *People* and *Transportation* each into two intermediate headings, and *Places* into four intermediate headings suggests that our structure might have benefited from greater complexity. This requires further research to see whether children, when looking for information using hierarchical subject directories, find depth more or less helpful than breadth.

## **7. Conclusion**

We are aware that this is a very small study involving only four children all of whom were girls and close to the limit at which they become young adults. This limits generalizations concerning children's concept mapping behavior. Nevertheless, it does provide a validation of our decision to omit the elementary school students in our Bonded Design team from the task of constructing the subject directory included in the completed web portal. Although differences can be observed between the hierarchical structure which we had constructed with young users in mind, and the girls' final concept map, these are minor and relate more to labeling than to categorization techniques per se. In this respect it confirms earlier findings that conceptual structures built by adults and children are strikingly similar (see, for example, Livingston & Andrews, 2005). It would be advantageous to repeat the task with a bigger number of children – boys as well as girls – and at younger ages. It would also be interesting to investigate whether children found our structure easier or harder to use than the children's version when actually employing it to find information.

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