Logical Reasoning Through Classification

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Logical reasoning skills developed through sorting, classifying and ordering activities are essential precursors to recognizing, extending and generalizing patterns and provide a foundation for understanding formal and abstract algebra in later years. While students may succeed at classifying data and objects that involve specific topics in mathematics (for example, pyramids, prime numbers and algebraic expressions), it is valuable for them to recognize that classification schemes are all based on similar forms of logical structures, whether in mathematics, science, biology or everyday life.

Adults often take for granted the abilities and experiences required for using and creating classification systems. How might an elementary teacher set up a filing system for activities? According to grade level? According to subject? Difficulties arise for the odd activities that span grade levels and/or subjects. What reasoning is made to determine where to file these activities that cross categories? Similarly, how might the materials in a classroom be organized and arranged for efficiency and ease of use? Should children's literature books be arranged alphabetically by title or author, or should they be sorted by other attributes, such as reading level or subject? Understanding classification requires an ability to recognize and identify similarities and differences and decide which attributes are most appropriate for arranging or sorting into sets or categories.

The ability to classify and sort objects by various characteristics or attributes into logical categories is a skill we use and are exposed to every day, often without being aware of its mathematical significance. For example, in our households we sort our laundry by color, such as light and dark, and perhaps further into subcategories of delicate and regular wash items. We arrange our kitchen cupboards according to a variety of attributes, such as cans, dried foods, dishes, plastic containers and so on. We usually place these groups of items according to a logical scheme related to size and/or function: pots and pans are assembled from smallest to largest near the oven; glasses are by the sink; plastic containers are stacked according to size and shape in the pantry; and the small odds and ends that may come in handy some day are put into the junk drawer. A place for everything and everything in its place (most of the time).

Not only do we create our own classification systems in our homes and offices, but we also use schemes created by other people to help us sort through information or to identify objects. Imagine a person surfing the Internet looking for teaching sites related to mathematics; she could use one of the search engine directories such as Yahoo or Canada.com. A directory is a means for classifying and sorting webpages by starting with general categories and following links to more and more specific categories. For example, the person will find the same or similar websites on teaching mathematics by following links such as these:

Science >Mathematics >Education >Teaching
Education >K12 >Mathematics
Canada > Science > Mathematics Education > Primary and Secondary Teaching

If a person was trying to find text resources for teaching geometry to children, he could do a search for articles and books on a library's computer system. Depending on his familiarity with the database's subject headings, he may need to experiment with key words to locate a reasonable number of entries relevant to his topic. For example, he might enter the key words geometry, children and activities. Depending on the database used, he may be able to narrow his search further using logical connectives such as AND, OR and NOT, and wild cards (for example, * or ?) for searching for multiple forms of a word (for example, geomet* for geometric, geometry, geometrically). The search may require more and more specificity depending on the number of hits or library resources identified. Perhaps he will have more luck with the following: geometr* AND (children OR elementary) AND activit* NOT

video. Once a reasonable and relevant list of library resources is created, locating the references requires familiarity with yet another classification system—either the Dewey Decimal System or the Library of Congress Classification.

Not only do we create and use classification schemes, but we, ourselves, fall into various classifications systems—biological, demographical and geographical.

Examples of Classification Systems

Taxonomy of Living Organisms

Kingdom:	*Animalia*
Phylum:	*Chordata*
Class:	*Mammalia*
Order:	*Primates*
Family:	*Hominidae*
Genus:	*Homo*
Species:	*Sapiens*

Blood Types

The four blood types—A, B, AB and O—are determined by the presence or absence of two types of molecules called A and B: A (has A not B), B (has B not A), AB (has A and B), O (has neither A nor B).

Fingerprint Classification System

The system used by the Federal Bureau of Investigation (FBI) in the United States recognizes eight different types of patterns: radial loop, ulnar loop, double loop, central pocket loop, plain arch, tented arch, plain whorl and accidental.

Postal Codes in Canada, such as T5J 4J4:

The first character represents a particular province or territory (or major area within the province); T is for all locations in Alberta.

The second character: 1–9 for urban locations, 0 for rural; 5 represents a major area within the City of Edmonton.

The third character represents a postal station or city post office in urban places or a set of post offices in a rural geographic area; J represents an area in downtown Edmonton.

In urban centres, the fourth character refers to one side of the street on a block face, a large business, an office building, or another destination. In rural areas it refers to a particular community.

Fifth and sixth characters continue to pinpoint the location further to a particular mail drop.

The last three characters of the postal code narrow in on the location of Canada Post Corporation in Edmonton.

These classification schemes—from organizing our kitchens to sorting mail—have a similar underlying logic. To create and make use of the schemes requires (1) the ability to think flexibly about the characteristics of the data or objects in the collection; (2) an understanding of the differences and similarities in attributes; (3) the ability to construct categories that sort data distinctly; (4) decision making for odd data to further clarify the description of a category; (5) a means for labeling or representing the categories; and (6) the (short-term) adjustments to the representations or descriptions as further data is collected and classified.

The examples of sorting and classifying provided above require logical reasoning skills to make sense of and make use of classification models essential in mathematics as well as in other subject areas. Sorting and classifying activities specific to mathematical attributes, such as size, shape and quantity, are addressed in every strand of the curriculum. For example, we sort numerical and non-numerical data for statistical purposes; we classify geometric shapes such as polygons into quadrilaterals, which can be classified further as rectangles and even further as squares; we distinguish between different types of numbers, such as even and odd, prime and composite, and whole numbers, integers and rational numbers; and we arrange and order objects according to their measurements, including length, volume and mass.

Pointing to the variety of classification schemes used and created daily begins to make explicit the underlying logic, principle methods and attributes by which data may be classified. Such knowing provides a foundation for enhancing generalization skills and logical reasoning in mathematics.