Graphical literacy

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Graphical literacy is the ability to read and write (or draw) graphs.

Isolated elements of graphical literacy already exist in most school curriculums, but as a concept it is not well developed or well taught. Some aspects of map or graph reading are taught in social studies curriculums. In a few reading courses, these simple graphical reading skills are subsumed as part of "study skills." Bits and pieces of graph drawing appear in vocational or mechanical drawing classes, mathematics classes, or in the art department. However, what I am proposing here is literacy in graphs that begins to approach word literacy.

Cognitive psychology background

The use of graphs to communicate information has been around since or before written verbal language. Pictures, maps, and other types of graphs have been used throughout the ages. However, educators have recently become more interested in nonverbal communication as part of the cognitive movement in psychology. Researchers have pointed out some interesting things; for example:

In nearly all right-handers, and in about 70 percent of the left-handers, the left hemisphere (of the brain) employs an analytic, sequential strategy appropriate for verbal proposition information. The right hemisphere characteristically uses a global or holistic, synthetic or appositional strategy, such as one might use in looking at a painting, where parts acquire meaning through their relation to the whole (Whittrock, 1978).

Another cognitive psychology ap-
Figure 1
Illustration of the Taxonomy of Graphs

1. **Lineal**
   - a. **Simple**
     - **STORY**
     - **BODY FOUND**
     - **GIRL DISAPPEARS**
     - **MAY 2**
     - **MAY 3**
     - **MAY 14**
   - b. **Multiple**
     - **HISTORY**
     - **LINCOLN**
     - **1861**
     - **GRANT**
     - **1865**
     - **HAYES**
     - **1873**
     - **POPE PIUS IX**
     - **1863**
     - **LOU XIII**
     - **1879**
     - **SMOKELESS POWDER**
     - **1868**
     - **OLEO MARGARINE**
     - **1873**
     - **LIGHT BULB**
     - **1879**
   - c. **Complex**
     - **Hierarchy**
     - **ORGANIZATION**
     - **Flow**
     - **COMPUTER**
     - **Process**
     - **CHEMICALS**
     - **Sociogram**
     - **FRIENDSHIP**

2. **Quantitative**
   - a. **Frequency Polygon**
   - b. **Bar Graph**
   - c. **Pie Graph**
   - d. **Complex**

3. **Spatial**
   - a. **2 Dimensions**
   - b. **3 Dimensions**

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384 Journal of Reading February 1981
approach has been through the study of imagery. Paivio (1974) has found that pictures and instructions to generate images facilitate memory. Levin (1976) has found that both children and adults remember pictures of objects better than names of objects. Graphs are an interesting way of presenting schemata, or as Confucius is reputed to have said, “A picture is worth a thousand words.”

**Reading teacher’s role**

I am proposing that reading teachers are well equipped to take active educational leadership in graphical literacy because they already have many skills that are readily trans-

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**Figure 1 (continued)**

4. **Pictorial**
   a. Realistic
   ![Realistic Pictorial Example]
   b. Semipictorial
   ![Semipictorial Pictorial Example]
   c. Abstract
   ![Abstract Pictorial Example]

5. **Hypothetical**
   a. Conceptual
   ![Conceptual Hypothetical Example]
   b. Verbal
   ![Verbal Hypothetical Example]

6. **Omitted**
   a. High Verbal
   ![High Verbal Omitted Example]
   b. High Numerical
   ![High Numerical Omitted Example]
   c. Symbols
   ![Symbols Omitted Example]
   d. Decorative Design
   ![Decorative Design Omitted Example]

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**Graphical literacy** 385
1. **Linear graphs** - Sequential data
   a. **Simple linear** - For example, a time line or simple nonbranching flow chart can be used in history, literature (a story line), or directions.
   b. **Multiple linear** - Parallel lines. For example, a set of three time lines that show terms of office of presidents, with a parallel line showing inventions, and a third parallel line that shows the reigns of English kings or queens.
   c. **Complex linear** - Complex lines that have branching, feedback loops, and diverse data. For example, a computer programmer's flow chart; a process chart; or a hierarchy chart for a business or governmental organization, a genealogy chart, or a sports tournament elimination chart.

2. **Quantitative graphs** - Numerical data
   a. **Frequency polygon** - Gives continuous data, can best show trends. For example, a normal distribution curve, growth curves, stock market fluctuations.
   b. **Bar graph** - Gives discrete data points, can best show the difference between two amounts. For example, it can contrast the size of enrollment for three different years.
   c. **Pie graph** - Best shows percent by various areas.
   d. **Complex numerical graphs** - Engineering graphs, multiple data graphs, higher mathematics graphs. For example, graphs drawn in logarithmic units, multiple line, or multiple variables.

3. **Spatial graphs** - Area and location
   a. **Two-dimensional** - Represent something flat. For example, road maps, floor plans, football plays.
   b. **Three-dimensional** - Represent height or depth plus length and width. For example, a map with contour lines showing mountains or valleys, mechanical drawings, or building elevations that accurately show dimensions.
   
   Basically, spatial graphs show the location of a point or the location and size of a line (one dimension), area (two dimensions), or volume (three dimensions). By use of special indicators or multiple graphs, different time periods can be shown.

4. **Pictorial graphs** - Visual concepts
   a. **Realistic** - More or less what the eye would see without significant distortion or elimination of detail. Can have an angle or point of view, selection of subject matter, selection of composition, background, and content. For example, photographs or realistic drawings, single or multiple color.
   b. **Semipictorial** - A recognizable image but with noticeable distortions in form, color, content, or omission of detail. For example, most Picasso paintings, schematic drawings showing cutaway or exploded engine, cartoons, or outline drawings.
   c. **Abstract pictorial** - Highly abstracted drawing which, however remote, has some basis in visual reality. For example, a single line across a space might represent the horizon; a vertical line, a person; a series of squares, a row of automobiles. Abstract drawings or graphs nearly always require some context, verbal explanation, or prior experience with the type of abstraction.

5. **Hypothetical graphs** - Interrelationship of ideas
   These graphs have little or no basis in visual reality.
   a. **Conceptual graph** - An attempt to communicate abstract ideas by using lines, circles, and other forms, with or without words or symbols. For example, a philosopher who labels the sides of a triangle "truth, beauty, justice"; a theoretical model of the reading process with boxes labeled "short-term memory and long-term memory."
   b. **Verbal graph** - The use of graphical arrangements of words or symbols to add meaning to the words. For example, a sentence diagram, semantic mapping.

6. **Intentional omissions from the Taxonomy of Graphs**
   a. **High verbal omission** - On the borderline between having some graph qualities and being purely verbal would be a typical outline with main idea and supporting details, or posters and advertisements composed with different sizes and styles of type that show emphasis or are aesthetically pleasing.
ferable. For example, it is quite possible to teach map comprehension by asking such typical reading comprehension questions as:

What is the main idea of this map? (To show the location of a housing tract)
What details support this main idea? (Tract location in the center of the map, only roads leading to the tract clearly marked)
What is the author’s purpose in drawing this map? (To sell houses)
How are the details interrelated? (Does road location have anything to do with rivers or mountains?)
What new vocabulary is used? What new symbols? (Arroyo, off ramp) (300m, R-1 zone)

I need not go on, but perhaps already you can see that many, if not most, typical “reading comprehension” types of questions can be asked of a map. A map is only one kind of graph; many types of reading comprehension questions can also be asked of a bar graph, a time line, or other kinds of graphs.

Singer and Donlan (1980) suggest that graphs could be taught using the Directed Reading Activity (DRA), which is similar to some types of reading lessons where the teacher conducts a prereading discussion including new vocabulary and background. The student reads the graph, then does activities related to the graph including answering comprehension questions or possibly drawing similar graphs.

Reading teachers, or teachers interested in reading, are further qualified to take a leadership role in graphical literacy because they are already part of the literacy education area and part of the communications field. Their knowledge of everything from individual differences to tests and measurements can be applied, and they are used to working with material from many subject matter areas.

But before going further into graphical literacy, let us give a more complete definition of graphs with a taxonomy and some examples. Most of what I am calling graphs fall into the five areas outlined in A Taxonomy of Graphs shown in Figure 1: Lineal,
Quantitative, Spatial, Pictorial, or Hypothetical. See Figure 1, Figure 2, and A Taxonomy of Graphs for details.

Graph uses
Graphs are used because they quickly communicate a concept often better than words. Even though many of them contain some words or numbers, the basic transmittal of information is nonverbal.

Graphs pack a high density of information into a small area. A very large statistical table can often be compressed into two or three simple lines on a frequency polygon graph. And even more than that, a curved line is an infinite number of points (if you remember your geometry), and theoretically every point can be read or interpreted, whereas a table necessarily has a fixed number of points. For many people, looking at a curved line shows a trend better than looking at a page of numbers.

The ability to read graphs is becoming increasingly important because they are being more widely used in newspapers, magazines, textbooks, and television presentations. Computers are learning to draw graphs in order to simplify massive amounts of statistics or complex mathematical data. Offset printing, now so widely used, makes the reproduction of graphs easier than former printing processes. Students in today’s schools can look forward to an increasing use of graphical presentations on computer terminals, in print, and in classrooms.

Drawing graphs
Reading and comprehending graphs is only half of graphical literacy. The other half is the ability to draw them. Students need to draw them so that they can better communicate ideas, so they can use them in studying, and so they can better understand them.

Drawing a graph can be a creative communicating experience similar to writing a paragraph or a story. There are many ways to express the same idea graphically, just as a writer can express a written idea in a variety of ways. Someday we may see a course in creative graphing just as we now have creative writing. In the meantime, a unit of a reading, communications, or writing class might well be devoted to graphing.

Graphing, or expressing ideas graphically, is already a well established part of some study skills courses. It should be developed. Outlining, summarizing, notetaking, and underlining are all fine study techniques; but they are all essentially verbal. Graphing can add another very important dimension to study techniques. Once the students start to think about applying graphing whenever possible, they will be amazed at how often it can be applied.

Teachers can help to develop graphing ability by making assignments just as they now do for writing. For example, take a section of a history book, science article, or short story and ask the students to make as many graphs as they can to illustrate ideas in the material.

Another interesting lesson for teaching graphing is to take a newspaper article, budget statement, or some other piece of writing with numerical data and ask the student to attempt to make a graph. You will often find that the article does not contain enough information to draw a complete graph. The students will learn that a graph contains far more information than most typical prose paragraphs about data. Or stated
another way, the graph more succinctly conveys the information.

Valuing graphs
We teach reading and writing because we value reading and writing. We teach mathematics because we value mathematics. We will only teach graphical literacy because we value it. If we do value graphical literacy, here are some things we can do.

- Allow some time for graphical literacy in the curriculum.
- Ask reading comprehension type of questions about graphs.
- Select texts that have a good use of graphs.
- Talk to students about the importance of graphs.
- Grade graphs in student papers.
- Work on extending the types of graphs a student uses.
- Have a graphing contest and prizes.
- Invite art and drafting teachers to reading and English classes to talk about graph use and development.
- Use graphs yourself on the chalkboard or the overhead projector in explaining ideas.

Conclusion
Graphical literacy—the ability to both comprehend and draw graphs—is an important communication tool that needs more emphasis in the school curriculum. Reading teachers, by virtue of their experience teaching reading comprehension, their practice in using materials from many fields, and their knowledge of educational principles, are qualified to teach graphical literacy and aid other teachers in developing units in this subject.

Furthermore, reading teachers often teach some graphing techniques in study skills segments of their courses, and these need to be further developed.

Helping students to develop graphical literacy can be akin to creative writing as a creative experience. Students should be encouraged to use graphing in all types of written communication and in study.

Finally, if graphing is to be included in the curriculum of reading, English, and most other subjects to a greater extent, it needs to be more highly valued. Some techniques for showing greater value for graphical literacy include graphing assignments and greater recognition on the part of teachers of the communication value of graphs.

References
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A Taxonomy of Graphs by Edward Fry
Too often, if you ask people what a graph is, they will tell you about only two or three kinds, such as a bar graph (contrasting two or more quantitiative amounts) or a pie graph (showing percentages). The taxonomy presented here both defines and broadens the term "graph." It attempts to show what is and what is not considered a graph. With five major categories and a number of subcategories, it attempts to expand the thinking of students and teachers about the kinds of information a graph can communicate. It is interesting that four of the five major categories of this Taxonomy of Graphs are not mathematical or, more accurately, not quantitative. By calling such diverse things as time lines, maps, and abstract graphs graphs still contributes to the developing ability of students to use these communication tools effectively.