GRAPHICS IN CHILDREN'S INFORMATIONAL TEXTS: A CONTENT ANALYSIS

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A DISSERTATION

Submitted to
Michigan State University
In partial fulfillment of the requirements
For the degree of

DOCTOR OF PHILOSOPHY

Curriculum, Instruction, and Teacher Education

2012

ABSTRACT

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This dissertation is comprised of two manuscripts resulting from a single study, which examines a) the types of graphics that appear, and in what frequencies, in children's informational texts, and b) the defining features of different graphics. Graphics are ubiquitous in children's informational texts and a lot is known about the impact of graphics on comprehension and learning. In spite of this, very little is known about what types of graphics appear in these texts. Through a content analysis, this study involved analyzing and codifying the graphics in 8 textbooks, 142 leveled readers, and 126 trade books that were in science or social studies domains and appropriate for use in 2nd and 3rd grade. Each graphic (12,238) was coded for specific type and function in the text (decorational, representational, organizational, interpretational, transformational, or extensional). Major findings included identification of 59 graphic types, which collapsed into 8 meta-type categories: diagrams, flow diagrams, graphs, timelines, maps, tables, and images, and simple photographs. Images and simple photographs accounted for nearly 90% of graphics, 30% of graphics represent written text, and 60% of graphics contain information not found in written text. Some statistically significant differences occurred across book types and between domains. These findings have implications for instruction and further research on visual literacy, and the details of graphic types contribute to a working typology of graphics found in informational texts.

The first manuscript focuses on the research questions regarding what graphics, and in what numbers, appear in children's informational texts and the differences between types of text

and domain. This manuscript, which is intended for publication in a research journal, includes a detailed argument regarding the importance of the study with regard to extant literature and the methods used. The paper contains descriptions of the graphic types and functions, as well as quantitative results, but the focus is on statistical findings.

The second manuscript is intended for publication in a practitioner journal. It summarizes the methods of the study and provides a brief survey of the quantitative data. In this paper, the focus is on the qualitative descriptions of the graphic types, categories, and functions, including visual examples. These descriptions can potentially contribute to a working graphic typology. This paper also addresses the implications of the data with regard to instruction, which includes a look at some of the challenges graphics may pose to students.

The findings from this study have implications for instruction as well as future research on instruction. These findings may also be of interest to authors, illustrators, and publishers, who choose the graphics that appear in texts. This data is confined to graphics and texts; many questions remain about learning from, and teaching with, graphics. There is also a need for research on graphics in informational texts at different grade levels.

ACKNOWLEDGEMENTS

This dissertation has been a very long, very difficult journey and there are many people to thank for helping me see it through to the end. First and foremost, I must thank my advisor, Dr. Nell K. Duke, for her extraordinary command of the field, unparalleled standards and expectations for excellence, and eternal patience during the myriad difficulties I faced throughout my doctoral studies. I must also take a moment to remember my first graduate school advisor, the late, great Dr. Michael Pressley. I came to this Ph.D. program to study with Mike, or MP, and I will always cherish the three years that I knew and worked with him. I began this adventure with Mike, but I would have given up on it long ago without the continuous feedback, support, and sometimes-ingenious pep talks from Dr. Katie Hilden, Dr. Nathan Jones, Chris and Nancy Jennison, Dr. Aimee Light, Dr. Kelly Cartwright, Dr. Rebecca Norman, Dr. Kate Roberts, and Andrew Croft. Thanks to all of you for helping me to refine my thinking and strengthen my writing, as well as my resolve. Only the truest friends can feign such convincing interest in someone else's dissertation! I would also like to thank the members of my dissertation committee, Dr. Cheryl Rosaen, Dr. Janine Certo, and Dr. Kim Maier, for sharing their intelligence and wisdom over the years. It was a mistake to move away from such terrific teachers and scholars, and I am fortunate to have been able to continue as their student from a distance. Finally, and most profoundly, I have to thank my husband, Jon, and son, Drew, about whom I need entirely new words to describe the extent of their love, patience, and support. Thank you, guys, for hanging in there with me.

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Introduction

Inception of the Dissertation

The issues and questions about the types of graphics that appear in children's informational texts did not occur to me organically or as a natural next step in the studying and research I did in my first three years of graduate school. Instead, after exploring two other dissertation topics without success, I asked my advisor, Nell Duke, for help. I was in a difficult position and was considering whether I should finish with an Education Specialist degree rather than continue with the dissertation. During our meeting, Nell suggested multiple dissertation ideas that were based on gaps in the research on informational texts and reading comprehension, areas I had been pursuing in my coursework and earlier research experiences. One of these ideas would be a text analysis of graphics found in informational texts. As I considered this possibility, it immediately seemed strange to me that, while graphics occupy an enormous amount of real estate in informational texts, we have no idea what they are or how they function in text.

I began to read about graphics, which are defined here as a picture or image of any kind that conveys information, their history, and the positive impact they can have on comprehension (e.g., Carney & Levin, 2002; Gambrell & Jawitz, 1993; Hannus & Hyona, 1999). In their meta-analysis of research on the impact of graphics on reading, Carney and Levin (2002) write, "… it is clear from that literature that pictures (at least, well-selected or well-constructed pictures) reliably improve the reading-to-learn process" (p. 7). The number of graphics in children's books increases by the decade (Carney & Levin, 2002; Simons & Elster, 1990), but what are the graphics that are out there? What is the nature of these graphics?

This dissertation focuses on the question, "What types of graphics appear in children's informational texts, and in what frequencies? Do they differ between types of text, specifically, textbooks, little books, and trade books? Do they differ between grade level, specifically second and third? Do they differ by domain, specifically science and social studies? Also, what is the function of these graphics in text (Carney & Levin, 2002)? Do they represent text in a literal way? Do they extend text by containing information found only in the graphics, not in written text?

In conceptualizing and carrying out this study, I have been influenced by the literature on the impact of graphics on reading, such as the Carney and Levin (2002) meta-analysis, studies not included in the meta-analysis (e.g., Hannus & Hyonna, 1999; Haring & Fry, 1979; Gambrell & Jawitz, 1993) and studies produced since then (Duke, Norman, Roberts, Martin, Knight, Morsink, & Calkins, 2012; Norman, 2010; Norman, 2012). This body of research shows that graphics can have a positive impact on reading, which, when combined with the ubiquity of graphics in children's informational texts, suggests it would be useful to literacy teachers and researchers to know more about the graphics in children's informational texts.

There is an additional purpose of this study, one that has become clearer to me over time. The demands on students' visual literacy are increasing (e.g., Oblinger & Oblinger, 2005; Riddle, 2009; Stafford, 2010), and as a result, there is a growing body of research (Duke, Norman, Roberts, Martin, Knight, Morsink, & Calkins, 2012; Norman, 2010; 2012) and discourse (Lancaster & Rowe, 2009; Moss, 2008) on visual and graphical literacy. Thus far, however, we have not had a common typology of graphics to use in this research and discourse. A potential typology of this kind has been developed from the data I collected and coded. As that data grew to include dozens of types of graphics, I saw that having names, definitions, and categories for all these types would facilitate the research, discourse, and also the instruction of graphics.

Overview of the Study

In order to get a broad look at the graphics that appear in children's informational texts, I included three different types of books—textbooks (8), little books (142), and trade books (126)—that children encounter both inside and outside the classroom. I included books intended for second and third grade readers (trade books were not leveled, but they were all recommended for second or third grade by one or more sources), in science and social studies domains, and from an array of publishers and series. I coded every graphic for background information about the book in which it appeared, where it appeared on a page, whether it had a label or caption, whether it was a photograph or illustration, its specific graphic type, and its function. A graphic qualified as a new type when it showed information in a distinctive way and required specific background knowledge from a reader in order to comprehend it. I began coding with a list of possible graphic types adapted from a well-known book aimed at practitioners, *I See What You Mean* (Moline, 1995), but my list quickly grew beyond it. Graphic functions were based on Carney and Levin's (2002) work and included decoration, representation, organization, interpretation, transformation, and extension. I developed a coding manual in which I described my coding methods, defined graphic types, explicated graphic functions, and gave visual examples for nearly everything. I entered codes into an Excel spreadsheet.

Before conducting statistical analysis, I collapsed the many types of graphics I found, 59, into eight meta-type categories. I calculated descriptive statistics to get frequencies and percentages for the 59 types, but most analyses used the eight categories and six functions. I ran cross-tabulations and did chi-square tests to look at differences in category and function among and between book types, grade levels, and domains. These analyses were done at the graphic-level and because of the size of the data set (12,238), I used effect size (Cramer's V) to evaluate the magnitude of statistically significant differences.

There were three major findings: 1) There were many different graphic types in these informational texts for children, 59, which could be collapsed into eight major categories: diagrams, flow diagrams, graphs, timelines, maps, tables, images, and simple photographs. 2) In spite of such a large number of graphic types and categories, nearly 90% of all graphics were images or simple photographs. 3) About 30% of graphics were representational, and 60% of graphics were extensional; that is, 60% of graphics contain information not found in written text. Notably, there were few significant differences among book types or between grade level or publisher, though there were significant differences in graphic categories between science and social studies (science contains more diagrams, while social studies contain more maps).

These findings have numerous implications for research, instruction, and publishing. The finding that there were so many graphic types and categories suggests that we need to learn more about how students manage the wide array of graphics they encounter, whether there are thresholds for numbers of times students need to see a particular graphic type in order to comprehend it, and the extent to which they can transfer comprehension of a graphic in one context, such as science, to another, such as social studies. There is a new study (Duke, et al. 2012) that suggests primary students can have difficulty understanding the ways in which graphics can represent written text and, furthermore, that students may not learn that graphics can extend text until sometime after third grade. Given that the present study found that over half of graphics extend text in some way, this is troubling indeed. It certainly suggests that there needs to be more focus on instruction of graphics and graphic literacy, though we do not know the extent to which we should emphasize images, given that they comprise the vast majority of graphics, or more complex graphics such as diagrams, maps, and graphs, given that these are the graphics that seem to have the greatest impact on comprehension (Carney & Levin, 2002). Publishers should perhaps reconsider the proportions of graphic types and categories that they include in texts. For example, they might include graphics from the more complex categories—diagrams, flow diagrams, graphs, timelines maps, and tables—while possibly reducing large number of variants.

This study has implications for both researchers and practitioners; I chose to write the dissertation in an alternative format (Duke & Beck, 1999), with one article intended for publication in a research journal and the other intended for publication in a practitioner journal. The research article contains the traditional components of its genre: a rationale for doing the study that is supported by the literature, an extensive report on the methods I used to collect and analyze data, and results that address the questions of what types of graphics there are, to what extent they appear, and to what degree, if any, they differ between text types, domains, and grade level. The practitioner paper summarizes the methods of the study and provides a brief survey of the quantitative data. In this paper, the focus is on the qualitative descriptions of the graphic types, categories, and functions, including visual examples. The implications of these findings on instruction are presented, as well as some possible suggestions for teaching graphical lite

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MANUSCRIPT ONE: LOOKING BEYOND SIMPLE IMAGES: GRAPHICS FOUND IN CHILDREN'S INFORMATIONAL TEXTS

Abstract

Graphics have important functions in children's informational texts and they impact comprehension and learning. This study examines a) the types of graphics that appear, and in what frequencies, in children's informational texts, and b) the defining features of different graphics. Through a content analysis, this study involved analyzing and codifying the graphics in 8 textbooks, 142 leveled readers, and 126 trade books that were in science or social studies domains and appropriate for use in second and third grade. Each graphic (12,238) was coded for specific type and function in the text (decorational, representational, organizational, interpretational, transformational, or extensional). Major findings included identification of 59 graphic types, which collapsed into 8 meta-type categories: diagrams, flow diagrams, graphs, timelines, maps, tables, and images, and simple photographs. Images and simple photographs accounted for nearly 90% of graphics, 30% of graphics represent written text, and 60% of graphics contain information not found in written text. Statistically significant differences in graphic categories and graphic functions occurred across book types and between domains. These findings have implications for instruction and further research on visual literacy, and the details of graphic types contribute to a working typology of graphics found in informational texts.

Looking beyond simple images: Graphics found in children's informational texts

Introduction

Children's informational texts are full of illustrations, photographs, and other graphics (e.g., Carney & Levin, 2002; Moss, 2008; Pappas, 2006; Smolkin & Donovan, 2005). Researchers have noticed an increase in the numbers of graphics in children's texts every decade since the 1970s (Carney & Levin, 2002; Simons & Elster, 1990), and in recent years, in addition to an increase of graphics, the layout of some informational texts for children has undergone many changes; text is not as linear as it once was and pages resemble websites, with graphics arranged all over the page (Dresang, 1999; Moss, 2007). Despite the trend of publishers adding graphics, which has resulted in the increasing ubiquity of graphics in children's informational texts, no researchers have systematically examined the graphics that are used in these texts.

There is growing evidence that graphics in informational texts contribute to reading comprehension (e.g., Norman, 2010; Norman, 2012; Styles & Arzipe, 2001; Walsh, 2003) and improve recall and memory of text (Gambrell & Jawitz, 1993; Peeck, 1974; Pressley & Miller, 1987). Moreover, there is evidence that some types of graphics are more effective for these gains than others (Carney & Levin, 2002). Graphics are also important for the comprehension of written text because they sometimes contain information not found in written text (Bishop & Hickman, 1992; Fang, 1992). Because graphics can play an important role in reading comprehension and knowledge-building, it would be valuable for researchers, practitioners, and publishers to know the types and frequencies of graphics in children's informational text.

Review of Literature

Graphics have important functions in informational text

While there are many types of images in text, this study is about graphics. A “graphic” is defined as a picture or image of any kind that conveys information. Therefore, by definition, a graphic is not merely a decorative illustration or other type of image, although it may be aesthetically pleasing. An example of a graphic is a drawing of a butterfly emerging from a chrysalis, a map of Pennsylvania, or a pie chart showing how a healthy diet is comprised of different food groups. Not all images in text are graphics; some images are strictly decorative, such as a colorful border around a page or embellished bullet points. Frequently, graphics contain text, which can include a word or phrase in a label (such as different parts of an insect in a simple diagram), written information within a table (such as the annual rain fall in the Amazon Basin in a table about habitats), or a sentence-long caption (such as the birth place of Abraham Lincoln in front of a realistic drawing of a log cabin).

In this study, I analyzed the graphics in a variety of informational texts, that is, a text “whose primary purpose is to convey information about the natural, social, [or physical] world, and that has particular linguistic features to accomplish that purpose” (Duke & Billman, 2007, p. 110). I looked at graphics in three types of children’s informational texts: textbooks, leveled classroom readers, aka “little books,” and trade books. Because all three types of books can be used in the classroom (while trade books are also used outside the classroom), including all three provides a broad view of the graphics children are exposed to in multiple contexts.

Researchers have been studying the impact of images and graphics on reading, as well as the numerous ways graphics functions in informational text, since the 1970s (e.g., Concannon, 1975; Harber, 1983; Simons & Elster, 1990; Duke & Kays, 1998; Carney & Levin, 2002). The functions I examine in this study are those that describe relationships between graphics and text (e.g., Carney & Levin, 2002), rather than relationships between graphics and readers (e.g., Levie & Lentz, 1982).

Levin (1981) and Levin, Anglin, and Carney (1987) established that graphics have five functions in text: decorational, representational, organizational, interpretational, and transformational. *Decorational* images are not true graphics because their purpose is simply to decorate a page and they do not contain any meaningful content of their own; an example would be a photograph of a parade at the beginning of a chapter on communities without any mention of parades. These decorational images are included in this study because, unlike decorative borders or embellished bullet points, decorational images resemble graphics; an image cannot be identified as decorational without analyzing its relationship to written text. A r*epresentational* graphic accurately reflects information in text. In the popular children's book *Brown Bear, Brown Bear, What Do You See?* (Martin, Jr., 1992), for example, each page has a picture that directly illustrates the text, from the titular brown bear to the yellow duck and purple cat. In this case, the graphics are decorational, but they are also representational. *Organizational* graphics provide a structural framework for the information in a text such as a detailed map or a diagram of a light bulb with all of the parts labeled. *Interpretational* graphics clarify "difficult" text (Carney & Levin, 2002) by showing it in a novel way. This could be a photograph of a feather and a bowling ball dropping to the ground to illustrate gravity. Finally, *transformational* graphics use visual mnemonic systems to improve readers' memory of text. For example, if the "B" in Bellevue were turned into a picture of a bell, that would be a transformational graphic.

In their 1981 article, Carney and Levin did not include a category that is discussed elsewhere: graphics that extend the text (Bishop & Hickman, 1992; Fang, 1996); in their 2002 article, however, they recognize the importance of this function, though it was not included in the meta-analysis with their five original functions. In this sixth category, *extensional*, a graphic contains information not found in the body of text. When an extensional graphic appears, complete comprehension of the text can only occur when both the text and the graphics are read and integrated.

The Carney and Levin (2002) piece is a meta-analysis of research on the impact of graphics on reading comprehension and, more specifically, the way different graphics, according to their function, affect comprehension. One important finding is that the effect size of gains is related to graphic function. More specifically, using the functions described above, decorational graphics have no effect on reading comprehension, and in fact may have a slightly negative impact. Representational graphics have a moderate effect size of about 0.5. Organizational and interpretational graphics both have an effect size of around 0.75, which is considered large, with the interpretational graphics showing a slight edge over the organizational. Finally, the transformational graphics have a large effect size of about 1.4. In terms of the present study, these findings have an important implication: With data that suggests that the type of a graphic is related to the degree of its impact on reading comprehension, it seems that we should learn as much as possible about the types of graphics that appear in children's informational texts and with what frequency and in what proportion.

Graphics matter in reading comprehension

There is an established body of research on the role graphics play in learning to read and reading comprehension. In the body of research on the impact of graphics on reading comprehension, there are a small handful of studies that show that graphics have no impact on comprehension (Brookshire, Scharff, & Moses, 2002; Miller, 1938; Rose & Robinson, 1984).

Other than these few studies, however, all of which used fiction texts and illustrations, there is overwhelming evidence that graphics are beneficial to reading comprehension in general (e.g., Bishop & Hickman, 1992; Bromley, 2001; Gambrell & Jawitz, 1993; Guttman, Levin, & Pressley, 1977; Hannus & Hyona, 1999; Rusted & M. Coltheart, 1979; Rusted & V. Coltheart, 1979; Schnotz, Picard, & Hron, 1993; Small, Lovett, & Scherr, 1993; Styles & Arzipe, 2001; Walsh, 2003) as well as specifically with nonfiction and informational texts (Bishop & Hickman, 1992; Hannus & Hyona, 1999; Levin & Barry, 1980; Norman, 2010, 2012; Rusted & M. Coltheart, 1979; Rusted & V. Coltheart, 1979; Schnotz, Picard, & Hron, 1993; Small, Lovett, & Scherr, 1993).

Researchers are beginning to study what children need to know in order to comprehend graphics in written text. In a recent study, researchers have identified “concepts of graphics” and investigated when children acquire these concepts (Duke, Norman, Roberts, Martin, Knight, Morsink, & Calkins, 2012). Unlike the research on graphics and comprehension, which investigates the ways in which students use graphics to learn new information, this study focuses on how children understand graphics themselves. The premise is that, before a student can “extract meaning” (p. 7) from a graphic, she must possess knowledge of “concepts, categories, and conventions” (p. 7) relating to the graphic. The authors identified eight concepts that they hypothesized may develop between Pre-K and grade 3: *Action*, *Intentionality*, *Permanence*, *Relevance*, *Representation*, *Partiality*, *Extension*, and *Importance*.

The most important findings, as they pertain to this study, are that children in this age range largely do not understand that graphics sometimes extend the information found in the written text and, furthermore, some young students do not understand some of the ways in which graphics represent text. For example, they may not understand or fully understand *Partiality*, that a graphic may only represent a portion of written text, or *Importance*, that all information in a graphic is not equally important. If students do not understand the properties of graphics, they may be unable to use graphics to learn information.

We need a working typology of graphics

Researchers and teachers are currently lacking a common set of terms and definitions for discussing the myriad types of graphics in informational texts. Carney and Levin's (2002) typology has broad categories of graphic functions, but does not include specific graphic types and meta-type graphic categories. The most comprehensive list of this kind thus far is in *I See What You Mean: Children at Work with Visual Information* (Moline, 1995). This book is often cited in guides for practitioners on how to use graphics, both for how they appear in text and also as tools for writing (e.g., Bahr, Pendergast, & Bahr, 2005; Duke et al., 2012; Richards & McKenna, 2003; Stead, 2006). However, Moline's (1995) typology is based upon his informal observations as a children's book author and illustrator, but the typology detailed in this study is the result of a systematic collection and analysis of a corpus of different kinds of informational texts. A research-based typology could be enormously useful to researchers and teachers alike by establishing a set of terms and definitions to use while discussing graphics in research, teacher education, and the classroom.

It is increasingly important to establish a typology of graphics because, as we continue into the digital age, we are increasingly inundated with visually rich and complex multimedia. Children of all ages look to the internet for information (Bomer, Patterson, Zoch, David, & Ok, 2010; Dodge, Husain, & Duke, 2011; Kinzer, 2010) and it is widely accepted that today's students learn to make meaning in multimodal ways that go beyond the written word to include visual and spatial elements (e.g., Bomer et al., 2010; New London Group, 1996; Westby, 2010), which means students are immersed in more visual media than they used to be. Multimodal learning theory (e.g., Jewitt, 2008; Kress, 2003) recognizes that there has been a shift, in literacy and literacy learning, “from the dominance of writing to the new dominance of the image,” (Kress, 2003, p. 1). The more that researchers, teachers, and publishers can recognize the different types of graphics our students are immersed in, and can use a common set of terms to describe these graphics, the more effectively we can understand and communicate about graphics in research, teacher education, and the classroom. Furthermore, because of these “shifts” from writing to image, there is, and will continue to be, a growing need for communication about graphics.

In summary, the literature demonstrates that graphics can benefit reading comprehension and that, according to Carney and Levin’s meta-analysis (2002), certain types of graphics—organizational and interpretational, for example—have more impact on reading than others, such as purely decorational graphics. Graphics are ubiquitous in children’s informational texts and, in fact, increase in number every decade (Carney & Levin, 2002; Simons & Elster, 1990). There has been no research thus far analyzing the types of graphics in children’s informational texts; with this data, we may be able to learn more about how to maximize the effect of graphics in children’s informational texts on reading and learning.

Research Questions

This study addresses the following questions:

- What types of graphics are contained in informational textbooks, little books, and trade books appropriate for second and third graders in the areas of science and social studies?
- With what frequency do these graphics occur in textbooks, little books, and trade books; science and social studies texts; and second and third grade texts? Do these frequencies differ at a level of statistical significance?
- What are the defining features of each of these types of graphics and what function do they serve, as defined by Carney and Levin's (2002) six functions of graphics in text?

Method

Overview of methods

This study is a content analysis using a constant/comparative approach (Glaser & Strauss, 1967; Strauss & Corbin, 1998). I began with a list of possible types, adapted from Moline (1995), though I expanded greatly beyond that list. I used a pre-set representative sample of children's informational texts, as detailed below, and coded them for the information listed below. I reached saturation before I finished coding.

Sample

Three types of texts were used in this study: science and social studies textbooks (8) for grades 2 and 3, little books (142) from five series in the areas of science and social studies for grades 2 and 3, and trade books (126) on science and social studies topics found in bookstores. Texts from grades 2 and 3 were chosen for this foundational study because they occur during the middle of the elementary years. Across all three types, only informational texts were included; there was no realistic fiction or fiction-nonfiction hybrid text included in the sample. Because the study focuses on informational texts, books were chosen from the content areas, science and social studies.

Textbooks. Textbooks were included in this study because they play an important role in content learning in classrooms. The textbooks used in the study were on one or more of the approved adoption lists for grades 2 – 3 science and social studies in three large states that are known for influencing textbook adoption nationwide (Hiebert, 2005; Sadker & Sadker, 2003): California, Texas, and North Carolina. The following textbooks were used in this study: Houghton Mifflin Harcourt School Publishers, *Social studies: Neighborhoods*, Grade 2; houghton Mifflin Harcourt School Publishers, *Social studies: Communities*, Grade 3;

Macmillan/McGraw-Hill, *Timelinks: People and places*, Grade 2; Macmillan/McGraw-Hill, *Timelinks: Communities*, Grade 3; Houghton Mifflin Harcourt School Publishers, *Discovery works*, Grade 2; Houghton Mifflin Harcourt School Publishers, *Discovery works*, Grade 3; Macmillan/McGraw-Hill, *Science: A closer look*, Grade 2; Macmillan/McGraw-Hill, *Science: A closer look*, Grade 3.

In total, eight textbooks were included in the study, four science and four social studies, four each in grades two and three; four from Houghton Mifflin Harcourt School Publishers and four from Macmillan/McGraw-Hill. In other words, there are two textbooks each, one from Houghton Mifflin and one from Macmillan/McGraw-Hill, for science and social studies, and second and third grade.

Within the textbooks, I coded only the pages that included regular informational text, that is, the “lesson” sections of the chapters and units. I did not code introductory pages to units or chapters, the pages between units or chapters, review pages, or other pages that are supplemental to the regular lesson sections because a) I was less sure that students read those pages compared with written text, and b) those pages rarely contained informational text (instead, those pages were comprised of science experiments and other projects, biography, review exercises, nonfiction poetry, and other types of text). When review questions appeared at the end of the regular lesson sections, I did not code any of the images that sometimes appeared with the questions; that is, again, I only coded graphics that were associated with the main body of the text.

Little books. Leveled readers, also known as, “little books,” are so widely used in classrooms that they have been the subject of many research studies (e.g., Hiebert & Fisher, 2007; Hoffman, Roser, Salas, Patterson, & Pennington, 2001; Menon & Hiebert, 2005). In this study, little books were included from five different series. I included only the books explicitly labeled “science” or “social studies.” All little books in the following list are leveled by grade or other text leveling measurements such as the Guided Reading and/or Reading Recovery levels. Books leveled according to these systems ranged from J-N using Guided Reading and/or 17-21 using Reading Recovery levels for grade 2. Books ranged from N-P and/or 21-23 for Grade 3. When books fell on the border between second and third grade (N and/or 17), I deferred to the publisher’s grade recommendations. Different series contain different numbers of titles overall, and also different proportions of science to social studies and books for Grade 2 and Grade 3. Because of these factors, and because I omitted titles that are not informational text, the numbers of books coded is different for each series. Means and percentages were used and therefore analyses take into account different numbers of books from different series.

The series included in the study were chosen, in part, because they come from major publishers of educational texts and are commonly found in elementary school classrooms. These series were chosen also because each one had a distinctive look to it and, as such, I expected that, as a group, they would contain a range of graphics. The series included in the sample are *Leveled Readers*, Houghton Mifflin Harcourt School Publishers; *Windows on Literacy*, National Geographic; *iOpeners*, Celebration Press/DK; *Discovery Links*, Newbridge; *Explorations*, Okapi.

As with the textbooks, above, I only coded the main body of the text in the little books. I did not code indexes, glossaries, or review pages. I also did not code any graphics associated with review questions in the text. Because not all little books have review questions, and because I did not include review questions in the textbooks and trade books do not contain review questions, for consistency, I did not code them in the little books.

Trade books. Trade books are the third type of text used in the study, as they are also another type of informational text frequently encountered by children, both in school and out. The trade books came from three different Barnes & Nobles and two Borders Bookstores (before Borders closed). The trade books are not leveled, but every title is recommended for grade 2 and/or 3 by at least one of the following sources: *School Library Journal*, *Booklist*, or Amazon. I coded every book that was available in the five bookstores I sampled. Many of these books were part of series (e.g., DK Eye Wonder, Jump Into Science, Smart Kids, If You Lived in the Time).

Table 1.1 shows the total number of books; the number of textbooks, little books, and trade books; the number of science and social studies books; and the number of second and third grade books. Altogether, the books came from 30 different publishers.

Table 1.1

Numbers of and Types of Books Used in the Study

		Domain		Grade level	
Type	N	Science	Social studies	Second	Third
Textbooks	8	4	4	4	4
Little books	142	88	54	76	66
Trade books	126	88	38	N/A	N/A
Total	276	180	106	80	70

Procedures

I entered coding of graphics into an Excel spreadsheet. Each graphic corresponded to one line of data with information about the graphic and the book it appeared in. The unit of one graphic was defined as a graphic whose information and/or representation is self-contained. Graphics containing multiple images—such as flow diagrams—were coded as a single graphic. For each graphic, I recorded the following information: type of book (i.e., textbook, little book, trade book); content area (i.e., science, social studies); grade level (i.e., second or third), if applicable (i.e., for textbooks and little books); publisher; title; author; total number of pages coded in each text; total number of graphics coded in each text; page number; graphic number (I developed a system for ordering the graphics—left to right, top to bottom—so that every graphic can be identified by number on a page); caption, label, or none (a caption was defined as a sentence accompanying a graphic; a label is a word or phrase; if a graphic had both, it was coded as having a caption because captions typically contain more information than labels [Pappas, 2006]); photograph, illustration, or not applicable ("not applicable" in the case of certain tables); type of graphic (specific, descriptive type, such as "bar graph," "region map," or "flow diagram with cyclical sequence"); and function of graphic based on Carney and Levin's (2002) six functions of graphics.

Before I began to code, throughout the entirety of the coding process, and during the inter-rater reliability process, I devised and expanded upon a coding manual that describes each coding procedure, lists each code, provides definitions, provides examples, and records coding decisions in difficult cases (though I took care not to include any examples in the coding manual from texts involved in the inter-rater reliability check). The examples included many and multiple visual examples, not only of each specific type of graphic, but also, for example, of what constituted one graphic, how to determine whether a graphic has a caption, and how to determine the function (Carney & Levin, 2002). See Appendix B for a description of the coding manual.

As listed above, each graphic was coded for the specific type of graphic it is, and its function in the text (Carney & Levin, 2002). I began with a list of possibilities (from Moline, 1995) and, as expected, the final list of types is much longer than the original one (also, not all the graphics from the original list are on the final one, as some types of graphics on the original list were not found in the corpus). I used the method of constant comparison (Glaser & Strauss, 1967) to expand my list of categories until there were no new categories and no categories could be combined. In order to qualify as a new type, a graphic had to meet the following criteria: it presents information in a way that is different from any existing type and it presents a different interpretive task for the reader. For example, there is no difference in the type of information contained in a vertical or horizontal timeline. Therefore, these would not be considered different types of graphics. There is, however, a difference in the type of information contained in a scale diagram that uses conventional units of measurement and a scale diagram that uses picture units. As a result, these two different types of scale diagrams were coded as two different types of graphics.

Certain graphic types have features in common; there are many different types of maps, for example, such as route maps, region maps, or topographical maps, but all maps show geographical, sociological, or scientific information about an area. Similarly, there are numerous graphs, including bar graphs, line graphs, and pie charts, all of which show numeric or quantitative information in a spatial format. Because of these commonalities and because the list of specific graphic types grew very long, I collapsed the specific graphic types into larger categories after coding was complete.

To test the validity of the meta-type categories I developed, I had another visual literacy researcher, an expert who did not collaborate on this project in any other capacity, develop a set of meta-type categories based on the long list of specific graphic types I identified. I provided the researcher with the list of graphic types (including a visual example of each one) and, without any information about my eight meta-type categories, asked that she collapse the list of graphic types into a set of ten or fewer meta-type categories. She developed seven meta-type categories, five of which were identical to mine (diagrams, graphs, maps, photographs, tables), one of which was similar (illustrations), and one that differed (charts). The researcher then evaluated my eight meta-type categories and judged that they "were logical and made sense" and, describing her illustrations vs. my images category, said, "Your use of this category made more sense to me as I recategorized based on your themes." The meta-type categories are discussed in more detail in the Results section.

The other "type" code for each graphic is the one that shows its function in the text per Carney and Levin (2002). Each graphic received a number, 1-6, to correspond with one of these functions: decorational, representational, organizational, interpretational, transformational, and extension. Descriptions of each of these functions are provided in the literature review section. It is important to note that a graphic was coded as representational only if it provided exactly the same information found in the written text; if a caption or label added any new information whatsoever, the graphic was not coded as representational. Even if the "new" information in the graphic was not directly related to the written text or it only added a small amount of information, it was coded as extension; similarly, if the new information in a caption appeared in the written text on a latter page (than the page containing the graphic), it was also coded as extension. When coding tables, if the table included any information not found in the written text, it was coded as extension. If a table contained only information found in the written text, it was coded as organizational.

In addition to evaluating the graphics for type and function, which included reading the labels and captions, I also read the written text in each book. Because I evaluated the graphics' functions, which are based upon the way the graphics interact with the information in the written text, it was necessary to read the written text.

Inter-rater reliability

I trained a fellow researcher with the coding manual and a variety of practice texts, which were not part of the sample. Because of the irregularity within and between types, textbooks, little books, and trade books, she coded a random sample of texts stratified by book type. This included one unit from each textbook, 1-2 examples of little books and trade books from each series, plus 15% of trade books that were not part of a series. Within each category—series, domain, and grade level (where applicable)—the titles were randomly selected. We calculated intercoder reliability by using percent agreement. The sample used for inter-rater reliability testing included 2,431 graphics, or 0.20% of the corpus. We achieved 92% agreement in specific graphic type (using the specific graphic types rather than the meta-type categories), and 84% in graphic functions.

Statistical analyses

My research questions ask what types of graphics appear in informational texts and with what frequency they appear. I computed descriptive statistics to show the distribution of graphic types, graphic meta-type categories, and graphic functions in each type of book, each domain, both domains, each grade level (except for trade books), both grade levels, and with the total set.

My research questions also ask whether the differences between categories were significant. For comparative statistics, because the data was categorical, I used cross-tabs and chi square analyses to compare graphic categories and functions in the following ways: graphic categories (8) and book types (3) (book types in both domains and book types of each domain [science and social studies]); graphic functions (6) and book types (3) (book types in both domains and books types of each domain [science and social studies]); graphic categories (8) and grade level (2) (excluding trade books); graphic functions (6) and grade level (2) (excluding trade books); graphic categories (8) and domain (2) (science and social studies); graphic functions (6) and domain (2) (science and social studies).

Statistical tests could not be conducted for all of these relationships because the data did not meet the assumptions required by the test (the number of graphics for graphic categories or functions were not large enough for some of the book types, grade levels, or domains). In the graphic category analyses, the number of graphics coded as Timeline was too small across the three book types and between domains to include them in chi square analyses. In the graphic function analyses, transformational graphics and organizational graphics were omitted from significance testing for the same reason. However, tables of descriptive statistics show numbers and percentages of all graphic categories and all graphic functions.

After these analyses, I conducted a second round of chi-squares in which I focused the analyses in two ways. One, in order to isolate a) diagrams and maps by domain, I cross-tabulated a) diagrams, maps, and “other categories” (flow diagrams, graphs, timelines, tables, images, and simple photographs) with science and social studies. Two, in order to compare only the two most frequent graphic functions, representation and extension, I collapsed the other four functions (decorational, organizational, interpretational, and transformational) into one group and, using representation, extension, and “other functions,” repeated all crosstabs and chi squares involving the six functions mentioned above.

All descriptions, crosstabs tables, and chi-square tests of association were run at the graphic level. The analyses did not take into account dependence of each (or any) book on graphic category or function, which is a limitation of the analyses. Because of the large sample size, however, the data would likely reject the null hypothesis anyway. For this reason, effect sizes (Cramer’s V values) were used to measure the strength of relationships.

Results

The data showed that there were many specific types of graphics in these children's informational texts and they represent eight broader categories. Of those eight categories, images and simple photographs were most common. Graphics with representation and extension functions were the most prevalent, with half of graphics in the corpus extending written text.

Graphic types

Specific graphic types. Of 12,238 graphics coded, there were 59 discrete types of graphics, which are listed in Table 1.2. There was a wide variety of graphic types, such as cross-section illustration hybrids (a drawing of a tree where only the roots were shown as a cross-section), scale diagrams with picture units (a drawing of a man next to a shark), magnified images (a microscope view of streptococcal cells), and flow diagrams with cyclical sequences (four small photographs—an egg, a tadpole, a froglet, and a frog—with arrows between them). Some of the distinctions were subtle, but important. For example, a tree diagram (a family tree) and a web diagram (a realistic illustration of animals in a forest next to a stream with arrows between all organisms that feed on each other) are similar in that they both show complex relationships with multiple parts. To comprehend a tree diagram, a reader must know that a) the relationships stem from one source, and b) the relationships grow more numerous and complicated the farther they get from the source. To comprehend a web diagram, a reader must know that the connections or relationships can occur in different direction, in different orders, or even simultaneously.

Table 1.2

Graphic Categories and Types

Graphic types	Frequency	Percent (All Graphic Types)	Percent (Within Graphic Category)
Diagram	**889**	**7.26**	**100.00**
Bird's Eye View Diagram	11	0.09	1.24
Cutaway diagram	28	0.23	3.15
Cutaway diagram with inset	1	0.01	0.11
Cross section illustration hybrid	40	0.33	4.50
Cross section illustration hybrid with inset	1	0.01	0.11
Cross section photograph hybrid	13	0.11	1.46
Cross section	62	0.51	6.97
Cross section with inset	1	0.01	0.11
Diagram with color key	1	0.01	0.11
Inset	76	0.62	8.55
Simple diagram	513	4.18	57.72
Scale diagram conventional unit	9	0.07	1.01
Simple diagram with inset	3	0.02	0.34
Scale diagram picture unit	130	1.06	14.62
Flow diagram	**239**	**1.95**	**100.00**
Flow diagram cyclical sequence	222	1.81	92.88
Flow diagram forked sequence	9	0.07	3.77
Tree diagram	2	0.02	0.84
Web diagram	6	0.05	2.51
Graph	**78**	**0.64**	**100.00**
Bar graph	64	0.52	82.06
Line graph	2	0.02	2.56
Pie chart	11	0.09	14.10
Pyramid diagram	1	0.01	1.28
Image	**4008**	**32.75**	**100.00**
Bird's eye view	215	1.76	5.37
Bird's eye view with inset	3	0.02	0.07
Character (foreign language)	19	0.16	0.47
Cartoon illustration	1063	8.69	26.53

Table 1.2 (cont'd)

Computer enhanced photograph	6	0.05	0.15
Fine art	14	0.11	0.35
Logo	22	0.18	0.55
Magnified image	48	0.39	1.20
Photograph of illustration	7	0.06	0.17
Radar image	3	0.02	0.07
Realistic illustration	2511	20.52	62.66
Realistic illustration with inset	5	0.04	0.12
Scientific model	4	0.03	0.10
Stop motion	8	0.07	0.20
Timeline graphic	71	0.58	1.77
X-ray	9	0.07	0.22
Map	**352**	**2.88**	**100.00**
Context map	1	0.01	0.28
Flow map	25	0.20	7.10
Flow map with key	13	0.11	3.69
Grid map	2	0.02	0.57
Grid map with key	1	0.01	0.28
Landmark map	52	0.42	14.78
Region map	49	0.40	13.92
Region map with key	27	0.22	7.67
Simple map	139	1.13	39.50
Simple map with inset	19	0.16	5.40
Simple map with key	18	0.15	5.11
Street map	4	0.03	1.14
Topographic map	1	0.01	0.28
Topographic map with key	1	0.01	0.28
Simple photographs	**6558**	**53.59**	**100.00**
Photograph	6520	53.28	99.42
Photograph with inset	38	0.31	0.58
Table	**84**	**0.69**	**100.00**
Column table	7	0.06	8.33
Pictorial table	15	0.12	17.86
Row and column table	60	0.49	71.43
Venn diagram	2	0.02	2.38

Table 1.2 (cont'd)

Timeline	**30**	**0.25**	**100.00**
Simple timeline	30	0.25	100.00
Total	12238	100.00	100.00

Broader graphic categories. From the specific types of graphics, 59, it was possible to identify meta-type categories, which are described in Table 1.3. One example of the variety of, and distinctions within, these categories include the various maps. There were simple maps (which display only geographic information, such as names of states and/or cities); flow maps (which display routes or patterns of flow, such as the Lewis and Clark trail or migratory patterns of animals); region maps (which display areas highlighted by color or symbol, such as animal habitats or where different crops are grown); landmark maps (which display a set or sets of features other than geographic information, such as with a map of the United States that shows where the National Parks are); grid maps (which use the grid system to teach navigation); topographical maps; and street maps. Except for landmark maps and street maps, each of these types of maps appeared with keys and without. Because using a key requires a distinct skill set, maps with keys and without keys were coded as separate types, but all maps were placed in the same meta-type category: maps.

Table 1.3

Summary of Graphic Categories

Graphic	Depictions	Examples
Diagrams	Components of a whole, static relationships, usually with labeled parts	Simple diagrams, scale diagrams, cross section diagrams
Flow Diagrams	Movement or change, complex or hierarchical relationships	Flow diagrams with cyclical sequences, flow diagrams with forked sequences, tree diagrams
Graphs	Quantities or numbers organized visually	Bar graphs, line graphs, pie charts, pyramid charts
Timelines	Events in time	Simple timelines, multiple timelines
Maps	Geographical, sociological, or scientific information	Simple maps, flow maps, region maps, all with keys or without
Tables	Groups, organized in rows and or columns	Column tables, row tables, row and column tables
Images	Information of all kinds, sometimes symbolic, requires interpretation by reader, may require background knowledge	Realistic illustrations, cartoon illustrations, birds eye views, x-rays, fine art, logos, foreign characters
Simple photographs	Photographic images	Photographs

The images meta-type category is comprised of all types of illustrations and other images that a) are not diagrams or maps, but b) require some interpretation by the reader. For example, a reader must be able to interpret the differences between a “realistic illustration” and a “cartoon illustration” in order to correctly comprehend them. A realistic illustration might be a to-scale rendering of a Tyrannosaurus Rex that includes detailed features such as claws and teeth, accurate colors, and its proper posture (to the best of our knowledge). A cartoon illustration might be an anthropomorphized T-Rex with googly eyes, wacky grin, and knife and fork in each claw. A reader must be able to recognize that the realistic illustration is an accurate depiction of a dinosaur, while the cartoon illustration is not; dinosaurs did not use knives and forks and this graphic is showing a T-Rex in a funny way. The category "simple photographs" are photographs that are not also something else; they are not x-rays or magnified images, for example. They are just pictures.

Frequency of graphic categories

In spite of the vast assortment of graphic types, 86.3% of graphics were images or simple photographs. Table 1.4 shows the number and percentage of graphic categories in each book type and overall. While the combined total of images and simple photographs were mostly consistent across book type, each type of book had a different proportion of images and simple photographs. Textbooks contained 66.9% simple photographs and 15.9% images, while trade books contained 36.2% photographs and 50.0% images. Little books had a much higher percentage of photographs, 80.3%, than images, 9.3%.

Table 1.4

Numbers and Percentages of Graphic Categories in Book Types

	Book Type			
Graphic	Textbooks	Little books	Trade books	All books
Diagrams	152 (6.7%)	144 (4.4%)	593 (8.8%)	889 (7.3%)
Flow Diagrams	80 (3.5%)	48 (1.5%)	111 (1.6%)	239 (2.0%)
Graphs	10 (0.4%)	15 (0.5%)	53 (0.7%)	78 (0.6%)
Timelines	15 (0.7%)	3 (0.1%)	12 (0.2%)	30 (0.2%)
Maps	100 (4.4%)	98 (3.0%)	154 (2.2%)	352 (2.9%)
Tables	35 (1.5%)	29 (0.9%)	20 (0.3%)	84 (0.7%)
Images	361 (15.9%)	307 (9.3%)	3340 (50.0%)	4008 (32.8%)
Simple Photographs	1512 (66.9%)	2659 (80.3%)	2387 (36.2%)	6558 (53.5%)
Total	2265	3303	6670	12,238

One unexpected finding was the 8.8% of diagrams in trade books, which is higher than the percentage of diagrams in textbooks (6.7%) and little books (4.4%) (see Table 1.4). One possible explanation is that, amongst the trade books (126), there was a much higher proportion of science books (88), which typically contain diagrams, to social studies books (38), which typically do not contain diagrams. The number of textbooks and little books were more balanced between science and social studies domains (see Table 1.1), but there was a much greater availability of science trade books than social studies trade books. In addition to the difference in diagrams between science and social studies texts, there was also a difference in maps, though social studies texts contained more maps than science texts. Table 1.5 shows significance in the differences in diagrams, maps, and other categories (grouped together), between science social studies, and both categories combined (with a small effect size of 0.22). Science texts contained 10.8% diagrams, versus 1.1% in social studies texts. Maps, however, comprised only 1.2% of graphics in science texts and 5.8% in social studies texts.

Table 1.5

Numbers and Percentages of Diagrams, Maps, and Other Categories Combined, by Domain

Graphic category	Science	Social Studies	Both
Diagrams	841 (10.8%)	48 (1.1%)	889 (7.3%)
Maps	97 (1.2%)	255 (5.8%)	352 (2.9%)
Other categories	6873 (88.0%)	4124 (93.1%)	10,997 (89.8%)
Total	7811 (100%)	4427 (100%)	12,238 (100%)

X^2 (2, N=12,238) = 573.604, p<0.001, Cramer's V=0.22

Frequency of graphic functions

As with the images and simple photographs, representational and extensional graphics accounted for nearly all graphics. Representational graphics show information exactly as it appears in written text and extensional graphics contain information not found in written text. A diagram of a flower with more labeled parts than the parts described in written text is extensional. Most maps, particularly those with insets and keys, are extensional. Insets in maps contextualize the map's location in a larger map, while the information in keys show more spatial detail than the written text can explain. Frequently, the nature of a graphic's caption made the graphic extensional. For example, a realistic illustration of 19th century Chicago engulfed in flames next to a passage about the Great Chicago Fire of 1871 is representational. If the realistic illustration has a caption that reads "Residents fled to Lincoln Park and took refuge on the banks of Lake Michigan," without mention of those details in the written text, it is extensional. Representational graphics comprised 31.7% and extensional graphics comprised 60.0% of graphics (see Table 1.6). There were more differences in proportions of graphic functions across book types than in graphic categories across book types. Little books had the most representational graphics, 39.6%, followed by trade books, 31.5%. Textbooks had the fewest representational graphics, 21.3%, and the most extensional graphics, 64.2%.

In further analyses, because representational and extensional graphics accounted for so many graphics overall, I compared those functions more directly with crosstabs containing representation, extension, and the other functions combined into one group. In this way, I looked for significant differences in representational graphics and extensional graphics between book type (see Table A.3), domain (see Table A.4), and grade level (see Table A.5). The tables show significant differences in each of these analyses ($p<0.001$), but the effect sizes (Cramer's V) were small, that is, equal to or less than 0.13.

There were higher percentages of interpretational graphics in textbooks and little books, 9.8% and 5.4% respectively, than the 0.3% in trade books (see Table 1.6). Interpretational graphics most frequently illustrated abstract concepts with concrete examples. A photograph of flags blowing in the wind next to a passage about force is interpretational, as is a realistic illustration of a popsicle before and after it melts next to a passage about solids or liquids. The explicitly educational nature of textbooks and little books, in which concepts like energy, force, or gravity need to be explained, may account for the higher percentages of interpretational graphics than in trade books. These concepts were frequently illustrated with graphics showing relatable examples. There were 0.1% organizational graphics (N=17) in all book types, with textbooks having the highest percent (0.5%).

Table 1.6

Numbers and Percentages of Graphic Functions in Book Types

Function	Book Type			
	Textbooks	Little books	Trade books	All books
Decorational	95 (4.2%)	145 (4.4%)	332 (5.0%)	572 (4.7%)
Representational	483 (21.3%)	1307 (39.6%)	2096 (31.5%)	3886 (31.7%)
Organizational	12 (0.5%)	2 (0.1%)	3 (0.0%)	17 (0.1%)
Interpretational	222 (9.8%)	179 (5.4%)	23 (0.3%)	424 (3.5%)
Transformational	0 (0.0%)	1 (0.0%)	0 (0.0%)	1 (0.0%)
Extensional	1453 (64.2%)	1669 (50.5%)	4216 (63.2%)	7338 (60.0%)
Total	2265	3303	6670	12,238

Decorational images, those images that look like graphics but do not contain information, comprised 4.7% of graphics across book types. This is notable because there were many decorational features that I did not code. Recall that part of my coding method was to exclude such visual decorations as borders, decorative bullet points, and recurring icons that signified a text feature (e.g., a light bulb that accompanied vocabulary words in margins), yet nearly 5% of remaining graphics were not in fact graphics, but decorational images. These decorational images were typically photographs at the beginning or end of chapters that related to text in a vague or general way, such as a photograph of a kangaroo next to a summary paragraph (that did not mention kangaroos) about Australia.

Discussion

The science and social studies informational texts for second- and third-grade readers included in this study contained many different types of graphics. In spite of this large number and variety of types, however, images and simple photographs overwhelmingly dominated the texts (almost 90% of graphics). About 30% of graphics in the corpus show information identical to that found in written text, while 60% of graphics contain information that does not appear in written text. These findings have important implications for instruction, publishing, and future research.

Images and simple photographs account for most graphics though there are many other types

On the one hand, there are many types of graphics in informational texts on science and social studies topics for young children, but on the other hand, most of them account for less than 10% of all graphics. The fact that a large number of graphic types accounts for a small percentage of graphics poses multiple challenges for instruction. For one, it is important to consider the difficulty that such a large range of graphics might pose for students, especially students in primary grades. It may be advantageous to students for teachers to focus on instruction of images and simple photographs because they account for nearly all graphics in informational texts at the second- and third-grade levels; certainly, that is where it seems instruction should begin. Because the other six graphic categories—diagrams, flow diagrams, graphs, tables, timelines, and maps—each contain distinct kinds of information, it may be beneficial for students to master them as categories before they learn about many specific types and variations of graphics within each category. Mastery of a specific type of graphic would not guarantee mastery of other types, even within the same category, but mastery of the features of graphic categories may be useful for identifying different graphic types within categories. It may be that, in order to teach graphics in those less common categories, teachers should supplement the graphics in textbooks, little books, and trade books. Graphics in these categories occur so infrequently, particularly flow diagrams, graphs, timelines, and tables, that students may need additional exposure to them in order to learn them.

Representation and extension functions dominate graphics in children's informational texts

The high rate of representational graphics also has implications for instruction, though perhaps not to the same degree as extensional graphics. The Duke et al. (2012) study shows that many students PK–3 are unsure about concepts of graphics that relate to the representation function, for example, that a graphic may represent only part of written text, or that some information in a graphic may be more important than other information. In other words, we cannot be sure how well students comprehend even representational graphics. Nevertheless, the information in representational graphics is also found in written text, so there is another avenue through which students may be able to get that information.

The roughly half of all graphics that extend written text are more problematic. In Duke et al (2012), there is evidence that the concept of extension in graphics is tenuous for many students, even as old as the end of grade 3. In fact, researchers postulated that the concept of extension "is not typically acquired until some time *after* third grade" (p. 30). If over half of graphics in this study contain information not found in written text, students need to know a) that they should be reading graphics in text, and b) how to read graphics in text to garner information not found in the written text. It should be borne in mind that extensional graphics were those that contained *any* information not found in the written text: the challenge for children is likely to be greater for some extensional graphics than others.

These findings also have implications with regard to the findings in Carney and Levin's (2002) meta-analysis. Representational graphics were shown, to have a moderate effect size of 0.5 on "learning benefits" (p. 20) when compared with purely decorational graphics, while organizational and interpretational graphics resulted in larger effect sizes (than representational graphics) of about 0.75. Representational graphics, which had a moderate effect on reading comprehension, comprise 31.8% of graphics in this study; organizational and interpretational graphics, which showed a moderate to large effect on comprehension, comprise less than 4.0% combined. The most effective graphic function, in terms of comprehension, transformational, which had a large effect size of 1.4, was observed only once in the corpus. Carney and Levin (2002) added "extensional" to their list of graphic functions, but there was no data on the impact of extensional graphics on reading comprehension to include in their meta-analysis. Other than the findings in Duke et al. (2012) described above, there is virtually no data on the effect of extensional graphics.

Based on the findings, publishers may want to make certain changes to textbooks and little books (because these texts are intended for use as learning materials in the classroom). Textbooks and little books could include more examples from the "other six" categories, though maybe not such a large variety as 46 (the other 15 are different types of images and simple photographs). They could also include more graphics with varied functions, such as organizational, interpretational, and transformational. Data shows that graphics with these functions have a better impact on comprehension than representational graphics (Carney & Levin, 2002), but currently they are rare in children's science and social studies informational texts for second- and third-graders. Particularly if publishers were to make these changes, teacher education and classroom instruction would have to become more focused on graphics and visual literacy than they are now.

One complication of the data presented here about graphic functions is that many graphics have more than one function. Presumably, for example, many of the graphics included in the children's informational texts in this study were chosen because they were decorational as well as representational or extensional. For this foundational study, I addressed that issue in data collection by coding each graphic for the "highest" function, but moving forward in the field of graphical literacy it may make sense to describe graphic functions in a way that allows for more nuance. One possibility is a multi-function system, in which a graphic could be coded for more than one function. For example, a table that organized information in the written text as well as related information not found in the written text would coded as organizational and extensional. Another possibility is a two-tiered system in which a graphic is coded as a) representational or extensional, and b) organizational, interpretational, or transformational (theoretically). In a two-tiered system the decorational function would be eliminated because it could be argued that all graphics have a decorational element to them.

Using a common graphic typology would be useful for the field

A common typology of graphics would be helpful for enacting changes in the graphics included in children's informational texts, as well as for continuing to conduct multiple types of research related to graphics. A common typology would also make it easier to educate teachers about visual literacy and for teachers, in turn, to instruct their students. Classroom materials that not only a) include a more thoughtful range of graphics than they do now, but also b) refer to those graphics with a common set of terms, would facilitate clear communication about graphics. It would also help researchers communicate about graphics with one another and with teachers and publishers. This typology could also be extended beyond children's informational texts to include examples of graphic types unique to the digital world.

Limitations and Directions for Future Research

There are multiple limitations to consider in this study. For the most part, I identified and defined the graphic types on my own. I consulted with an expert on visual literacy throughout data collection and coding, but because there were so many types and categories to establish and designate, the task may have been better suited to a small team who could discuss the identification of graphic types as they occurred. The inter-rater reliability testing with another researcher achieved high levels of agreement (92% in graphic type and 84% in graphic function), but it also would have been informative to have a teacher's input on the applied importance, in the classroom, of some of the subtler distinctions between graphic types. For example, there is a nuanced difference in the kind of information shown in a cross-section diagram and a cutaway diagram (i.e., it is a difference in dimension; a cross-section shows one two-dimensional plane, as with a bisected apple, while a cutaway shows depth of perspective, as when one wall of a house is removed to show the rooms and residents within). A reader needs to understand a different spatial orientation for each graphic, but in a primary classroom there may never be a need for teachers or students to make the distinction between such similar graphics. An experienced teacher's input may have been helpful with some of these instances. That said, by making the distinction between the two graphic types, they are available to the reader to use or disregard at his or her discretion.

Given the large size of the data set and the large number of subtle differences between graphic types and functions, I established very strict guidelines for coding in order to maintain consistency. While this is good practice, it can lead to some results that may seem contradictory. For example, in establishing function categories, which required constant interpretation, extensional graphics were those that contained *any* information not found in the regular text.

This is potentially problematic for two reasons. First, the additional information found in extensional graphics was sometimes minor or not integral to the main ideas of the written text. For example, in a passage about the life cycle of frogs, any photographs of frogs labeled with their full names (e.g., Red Eyed Tree Frog or Blue Dart Frog) were extensional graphics. A bird's eye view photograph of a delta with a caption naming the place was also an extensional graphic. I did not want to judge the quality or pertinence of information, whether in graphics or written text, so any additional information equaled extension. This was also the case with tables and graphs. Inherently, the purpose of tables and graphs is to organize information. Nevertheless, as with the examples above, any new information in a table or graph made the table or graph an extensional graphic. If a table or graph contained information found only in the written text, it was an organizational graphic.

This is a foundational study that raises many questions for further investigation. The informational texts in this study are used in, and recommended for, grades 2 and 3; looking at graphics in books for older and younger children would shed more light on the kinds of information graphics portray and how they portray them. In conducting these additional analyses, it might be beneficial to include content area experts in science and social studies for input about the ways in which graphics depict specialized information. As more classroom materials become digital, it would also be informative to analyze those materials, both to learn about the types and roles of graphics in them and to learn how they compare with textbooks and little books.

The more pressing areas for future research are those that examine how readers learn and utilize different graphic types and functions, as well as how to maximize the potential of graphics to positively impact comprehension. There are many questions, including whether it is better to focus instruction on breadth (displaying many examples of graphics in one category so that students can identify variations of, say, maps and know, generally, that a map contains geographical information of some kind) or depth (teaching the one or two most common types of each category by instructing students how to use those specific types when they appear in text). We need to know more about instruction by function, also. What are the ways teachers can help students maximize representational graphics to reinforce what they read in written text is one example. The extension function may raise the most questions, particularly because many children do not understand that graphics can extend text (Duke et al., 2012). It seems the first step would be to learn how to teach students that graphics may include information that they will not read or learn from written text alone. It is important to learn about teaching students to identify graphic information not found in written text and, as a next step, how to decide what information is most central to what they read in written text. Along with research on learning and teaching graphics in classroom settings, it would be helpful to do content analyses of teachers' guides to learn the ways in which (and the extent to which) graphics are intended for use in instruction.

Conclusions

Graphics in children's informational texts are important because they can help students comprehend and learn from written text. There is currently no established typology of graphics in the field and a graphic typology would be useful to researchers, publishers, teachers, and students. The data in this study gives a picture of the types of graphics that are in children's informational texts, how often they occur, and their function in text. There are many types of graphics, including myriad variations within each category, but the vast majority of graphics are images and simple photographs. Examining the efforts to maximize the effects of the graphics in children's informational texts may benefit the way students comprehend and learn from these texts as well as from the increasingly visual world around them.

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MANUSCRIPT TWO: FOUR INSIGHTS ABOUT GRAPHICS IN INFORMATIONAL TEXTS FOR CHILDREN

Abstract

Graphics are important for reading informational text: they benefit comprehension and the Common Core State Standards Initiative (2010) has set benchmarks for using graphics to make meaning in conjunction with written text. Graphics are also ubiquitous in children's informational texts, though there has been little data on the types of graphics that can be found in children's informational texts. Based on the findings from the author's recent study examining 12,238 graphics in 276 informational texts (textbooks, little books, and trade books on science and social studies topics) aimed at second- and third-graders, as well as from extant literature on graphical literacy, this manuscript presents four key insights about graphics in informational text: graphics have different functions in text, there are many types of graphics in children's informational texts, most graphics are simple photographs and other images, and most graphics represent or extend written text. This information has implications for teaching graphical literacy; these implications are presented, along with possible approaches to instruction.

Four Insights About Graphics in Informational Texts for Children

Introduction

One of the anchor standards for reading in *The Common Core State Standards for English Language Arts and Literacy K-5* (2010) is "Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words." More specifically, the *Common Core State Standards* says that, in grade two, students should be able to "explain how specific images (e.g., a diagram showing how a machine works) contribute to and clarify a text" (p. 13), and in grade three, "use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text," (p. 14). In other words, being able to read visual content in text is a fundamental goal and students should know 1) how graphics work, and 2) how to read them for information. In this manuscript I discuss four fundamental insights about graphics. These insights will give teachers a better understanding of the graphics found in a sample of children's informational texts and suggest implications for instruction that may help teachers and students achieve the graphical literacy goals in the Common Core.

Children's informational texts are full of graphics (e.g., Moss, 2008; Pappas, 2006; Smolkin & Donovan, 2005) and there is evidence that graphics can positively impact reading comprehension (e.g., Carney & Levin, 2002; Hannus & Hyona, 1993; Norman, 2012). The number of graphics in children's texts has increased in the last several decades (Carney & Levin, 2002) and, in recent years, some informational texts have become "digitally designed" so that these books have multiple blocks of image and text on a page that can be read nonlinearly (Dresang, 1999; Moss, 2008). As the world of information becomes increasingly visual (Lancaster & Rowe, 2009; Oblinger & Oblinger, 2005), the ability to read graphics becomes more important. Yet, in spite of these things, we do not know what types of graphics are in children's informational texts!

In this article, I share the results of a study exploring graphics in 276 informational texts aimed at second- and third-grade children, define major categories of graphics found in these texts, give examples of the many graphic types I found, and describe different functions of graphics as they relate to written text (Carney & Levin, 2002). This information provides us with a better understanding of graphics, as well as the challenges they may pose for students, and suggests a framework for what teachers may want to focus on when they teach graphical literacy.

Given the growing importance of graphical literacy, it would be useful if we, as teachers and other professionals, adopted a common typology of specific graphic types and categories. A graphic, as I define it, is a visual depiction of information. Graphics may be visually appealing, but they are more than just pretty pictures. Graphics extend beyond photographs or illustrations; they can also be, for example, maps, timelines, or graphs. Many, but not all, graphics have labels (a one- or two-word term, such as a name or place, or a brief phrase) or captions (one or more sentences describing the graphic). There is a collection of graphic types in Steve Moline's well-known and informative *I see what you mean: Visual literacy K-8* (1995, 2011). The typology detailed in this article is the result of systematic investigation of a large number of informational texts in science and social studies for second and third grade. It can be a helpful tool for communicating about graphics among teachers, researchers, teacher educators, and even, in some cases, students.

Counting and Coding Graphics in Informational Texts for Children

In Fingeret (2012), I set out to learn what types of graphics are found in children's informational texts. I analyzed textbooks (8) from two publishers, leveled classroom readers (142) from five series, called "little books" in this manuscript, and trade books (126) from as many qualifying publishers and series I could find in multiple visits to five bookstores. The texts were on science and social studies topics and leveled for second and third grade (trade books were not leveled, though all trade books were recommended for second and/or third grade by *School Library Journal*, *Booklist*, or Amazon). I included the graphics in regular text and chapters only, not the graphics in appendices, picture glossaries, or introductory or review pages between units in textbooks.

I started the project with a list of graphic types adapted from Steve Moline's *I See What You Mean* (1995), mentioned above, but throughout data collection I found many more graphic types than the ones on the original list. In order to qualify as a new type, a graphic had to a) depict information in a distinct way, and b) require some specific knowledge from the reader in order to interpret it. For each graphic, I coded what type it was, whether it had a label or caption (which I considered to be part of the graphic), and its function (along with information about the book) into an Excel spreadsheet. In 276 books, I coded 12,238 graphics. Drawing on the data from this study, as well as existing literature on graphics in text, I offer four insights about graphics.

Four Insights About Graphics in Children's Informational Texts

The insights I present deal with both the functions of graphics and specific graphic types. A graphic's function refers to the way it relates to written text, that is, how the information in the graphic relates to the information in the text (Carney & Levin, 2002). Graphic type is based on the type of information a graphic shows and the way in which it shows it. Both of these typologies provide important information about graphics and both showed interesting trends in the data.

Graphics have different functions in text

Carney and Levin (2002) identified six functions of graphics in text: *decorational*, *representational*, *organizational*, *interpretational*, *transformational*, and *extensional*. These functions do not pertain to how readers interpret graphics. Instead, they describe the relationship between graphics and written text.

Decorational images are not truly graphics because they do not contain information and only relate to the written text in a vague or general way. In the study, I did not code purely decorative features in text like borders, embellished bullet points, or the icons at the bottom of textbook pages that indicate the chapter or unit. Decorational images, however, resemble graphics because they are usually photographs or illustrations and I could only determine their lack of information by analyzing them along with other graphics. For example, a picture of a neighborhood swimming pool full of happy swimmers at the beginning of a textbook chapter on communities, with no mention of swimming pools in the written text, is a decorational image. A summary paragraph in a little book on China might have a photograph of a dragon costume in a parade. If there is no mention of celebrations or parades with dragon costumes in the paragraph, the image is decorational. Most decorational images appeared at the beginning or end of chapters or little books. Because decorational images resemble true graphics, unlike other decorative text features (such as colorful borders, for example), it is important to be able to identify them. In this study, 4.02% of graphics were actually decorative images.

Representational graphics show something literally as it is described in written text. Representational graphics do not add any new information, that is, no information that is not in the written text. Many graphics are representational. A representational graphic could be a realistic illustration of a Colonial village next to a passage about Colonial villages, or a photograph of a humpback whale next to a passage about humpback whales. Graphics without labels or captions are frequently representational. A photograph of a giant sea turtle next to a passage about giant sea turtles is representational. If the photograph has a caption that adds information about giant sea turtles, it is not representational (it is extensional). In this study, 39.54% of graphics were representational.

Organizational graphics organize information in the written text. Graphs and tables are primary examples of this function, though if a table or graph contained information not found in the written text, I coded it as extensional. This means that there were greater percentages of tables and graphics in the books than indicated by the percentage of organizational graphics, which was less than 1% overall.

Interpretational graphics illustrate an abstract concept, most likely scientific, with a concrete example. Interpretational graphics fall between representational and extensional graphics; they may contain new information, but only insofar as it illustrates a concept of some kind. An interpretational graphic could be a photograph of a wheel turned by a crank that accompanies a conceptual passage that a) defines torque, and b) does not describe cranks in particular. Another example is a photograph of a bowl of frozen ice cream next to a bowl of melted ice cream next to a passage that describes differences between solids and liquids—how heat interacts with a solid to turn it into liquid, the temperature at which water freezes (or melts)—without including the properties of ice cream specifically. Interpretational graphics were typically used with explicitly educational text (i.e., definitions of abstract ideas or properties) and they occurred far more frequently in textbooks and little books, accounting for nearly 10% of graphics, than trade books, in which they accounted for less than 1%.

Transformational graphics, theoretically (Carney & Levin, 2002), show information by turning it into a picture. An example would be the term “Liberty Bell” in which the “B” is transformed to look like a large bell with a crack in it. The “B” would then act as a visual mnemonic that the Liberty Bell is cracked. This graphic function is included in Carney and Levin’s work (2002), and is associated with an increase in reading comprehension, so I am including it in this paper. In my study, however, I only found 1 transformational graphic in the 12,238 graphics I coded.

Extensional graphics show information not found in written text; they extend written text. An extensional graphic might be a cutaway diagram of a space shuttle with more detail than provided in the written text), or a timeline of the Civil War showing all battles when only the battles of Gettysburg, Antietam, and Bull Run were described in the passage. All maps are extensional because they show surrounding information that contextualizes the focal point or points of the map. Frequently, labels and captions make graphics extensional. For instance, a bird’s eye view of a rice terrace may be representational when it accompanies a passage that says rice can be grown in patties or terraces; the same graphic is extensional when it has a caption that reads, “Rice grows in terraced fields cut into the side of a hill in Indonesia” (unless the main body of the written text already says that). Sometimes the information added in a label or caption is less important than the information in written text, but it was beyond the scope of my study to rank the importance of different types of information so any additional information qualified a graphic as extensional. Extensional graphics were more common than all other functions combined. Extensional graphics accounted for 51.37% of graphics overall, and just over 60% of graphics in textbooks. As will be discussed later in this paper, this large proportion of extensional graphics has important implications for instruction.

There are many graphic types in informational texts for second- and third-graders

I identified 59 distinct types of graphics in informational texts aimed at second- and third-graders (see Table 2.1). These ranged from flow diagrams with cyclical sequences (e.g., four photographs of a butterfly at different lifecycle stages with arrows in between), to route maps with keys (e.g., a map of North America showing migratory patterns, each in a different color, of indigenous animals), to cartoon illustrations (e.g., a drawing of a yellow sun with a smiley face and triangular "rays" emanating from it), to stop-motion (e.g., a time-lapse photograph of a frog hopping) and more. See Figures 2.1-2.24 at the end of the manuscript for descriptions and visual examples of the 24 most common graphic types.

Because there were so many graphic types and some of them occurred very infrequently, it made sense to combine them into broader categories. These categories are described below, in order from least common to most common: *timelines, graphs, tables, flow diagrams, maps, diagrams, images, and simple photographs*.

Table 2.1

Graphic Types (N=59) and Categories (N=8), From Least Common Category to Most Common Category

Category	Graphic types
Timelines	Simple timelines, pictorial timelines
Graphs	Bar graphs, line graphs, pie charts
Tables	Column table, pictorial table, row and column table, Venn diagram
Flow diagrams	Flow diagram cyclical sequence, flow diagram forked sequence, tree diagram, web diagram
Diagrams	Bird's eye view diagram, cutaway diagram, cutaway diagram with inset, cross-section illustration hybrid, cross-section illustration hybrid with inset, cross section photograph hybrid, cross-section, cross-section with inset, diagram with color key, inset, scale diagram with conventional units, scale diagram with picture units, simple diagram
Maps	Context map, flow map, flow map with key, grid map, grid map with key, landmark map, region map, region map with key, simple map, simple map with key, street map, topographic map, topographic map with key
Images	Bird's eye view, bird's eye view with inset, character (foreign language), cartoon illustration, computer-enhanced photograph, fine art, logo, magnified image, photograph of illustration, radar image, realistic illustration, realistic illustration with inset, scientific model, stop motion, x-ray
Simple photographs	Simple photographs

Timelines show events in time. They record history, summarize important events in chronological order, and show development. Timelines can show specific events only, or they can show dates at scaled intervals with specific events in between. Many timelines have images to accompany specific events, but not always. Timelines can show events along a single line, such as by showing landmark events in the invention and modernizing of the bicycle. Timelines can also show multiple lines concurrently, as with the development of written language among different peoples or in different regions. In science, timelines can show evolutionary trends and events, physical changes on Earth over time, and major events from prehistoric eras. In social studies, they can show any historical event or period, development of various discoveries and inventions, and events in a child's lifetime. In the study, timelines made up 0.25% of all graphics.

Graphs show quantities that are grouped and organized in a visual way. Graphs summarize and organize information so the reader can make quick comparisons and other interpretations. Graphs can establish patterns and comparisons between patterns, as in a line graph depiction of climate change. Graphs can show portions in a whole, as in a pie chart (graph) showing the favorite desserts of students in a classroom. They can also summarize large quantities of data to make it more accessible, such as bar graph of the number of birthdays, by month, in a school. In science, graphs can show data on weather and climate patterns, extinction rates of plants and animals, and measurements of physical phenomena (such as earthquakes) over time. In social studies, graphs can measure and compare populations and changes in populations, trends of all kinds, voting patterns, and public health data. Graphs accounted for 0.64% of graphics overall.

Tables show information about groups organized into rows and/or columns. Sometimes tables include images, but usually they do not. Tables can organize information for comparison or to show patterns. Tables can function basically as lists, as with a column table or row table showing favorite colors of every student in a class. Tables can show relationships between pieces of information, as in a row-and-column table comparing cultural habits (language, food, holidays) by country (France, Italy, Spain). Tables can sort items, such as a table of objects that float and objects that do not float. In science, tables may classify information about plants and animals, show data from experiments, and compare features of physical phenomena. In social studies, tables may show information about different populations and compare effects of historical events. Tables made up 0.69% of all graphics in the study.

Flow diagrams show movement, change, and cause-and-effect, as well as complex or hierarchical relationships. Flow diagrams organize information sequentially and usually include arrows and/or numbers, which show directionality or connections. They can show a single process, as in a life cycle sequence, or multiple processes simultaneously, as in a depiction of what happens to different materials in a recycling plant. Flow diagrams can show increasing complexity over time, such as with a family tree, and they can also show many connections at once, such as the multiple predator-prey relationship in an ecosystem. In science, flow diagrams can show cycles in nature, physical or chemical processes, technological systems, classifications of plant and animal kingdoms, and evolutions of species. In social studies, they can show "life cycles" of goods and services, historical causes-and-effects as well as changes over time, and genealogies. Flow diagrams made up 1.95% of all graphics in the study.

Maps show geographical, sociological, or scientific information about an area including, but not limited to, land or a body of water, in a spatial context. Maps sometimes help us orient ourselves in a spatial location, or they can show information over vast landscapes. Maps can show movement or routes, such as in a map of spice trading with India. Maps can show regions of all kinds, as in a map showing the native locations of different types of trees. They can also show change, as with a weather map. In science, maps can show migratory patterns, locations of specific physical phenomena, regions of different ecosystems and habitats, and topography of different landforms. In social studies, maps can show different industry-centers, famous routes taken by explorers, population patterns, features of cities, directions between locations, and highway systems. Maps made up 2.88% of all graphics in the study.

Diagrams show parts of a whole, or simple, static relationships; they normally have labeled parts. In diagrams, words (labels) and images “work together” to show meaning (Moline, 1995, p. 98). Sometimes a diagram shows parts of a whole a reader would not normally see, as in cross-sections (a bisected, two-dimensional, internal view of an object, see Table 2.2) and cutaways (a three-dimensional, internal view of an object when an outer layer is “peeled” away, see Table 2.2). Other times, they show a comparison between two things, such as with scale diagrams. Diagrams can illustrate many topics in multiple domains and provide a visual directory for new or difficult vocabulary. In science, they can show parts of animals and plants, details about the human body, sizes of living things, interior views of the Earth and other planets, and components of machinery. In social studies, they can show types of housing or transportation, details about the interior of different structures, such as pyramids or skyscrapers, and differences between geographical formations. Diagrams made up 7.26% of all graphics in the study.

Images show information of all kinds and require interpretation by the reader. Images show things realistically, unrealistically, and symbolically, and a reader needs to know how the information is being shown in order to comprehend it. Images can show a view from a particular perspective, like with a bird’s eye view of the Grand Canyon, or under special circumstances, as in a magnified image of cells under a microscope. An image may represent something else, like the three-arrowed triangle symbol for recycling. Images, because realistic and cartoon illustrations are included in the category, can show information on any topic. Images made up 32.75% of all graphics.

Simple photographs are just photographs; they are not also something else. They can show practically infinite types of information on science or social studies topics. Simple photographs made up 53.59% of all graphics.

The vast majority of graphics represent and extend written text

One way to interpret the dominance of representational and, in particular, extensional graphics is that we should treat every graphic as a potential source of information. As educators, we tend to emphasize text over graphics to a large extent; one need only reflect on the famous *Concepts of Print* assessment (Clay, 2005), which contains merely two questions about graphics. One of these questions reinforces the notion that the parts of books that we read are printed words and *not* graphics! More focus on instruction of graphics will be beneficial to students’ literacy learning and will work toward addressing the graphical literacy benchmarks in the Common Core.

In a new study (Duke, Norman, Martins, Roberts, Knight, Morsink, & Calkins, 2012), researchers showed that many students, PK-3, have difficulty with some of the concepts related to representational graphics, specifically that graphics can represent only part of written text or that all information in graphics is not (necessarily) of equal importance. As a result, we do not know how well students can comprehend representational graphics, Extensional graphics may be even more challenging, both conceptually and in terms of content comprehension. In fact, research by Duke et al. (2012) suggests that children typically do not develop the concept of extensional graphics until sometime after third grade. Knowing that many graphics in second and third grade informational texts, indeed over half, are extensional, it seems critical that we develop and implement instruction that teaches the concept of extensional graphics. Because so many graphics are extensional, teachers and students may need to treat *every* graphic as an opportunity to learn information not found in written text. The extension function is complicated, for teachers and for students, by the fact that not all extensional information found in graphics is essential to the main ideas in written text. Remember that, in this study, *any* additional information made a graphic extensional; some of that information was, at most, peripheral. It was not my role to judge the importance of extensional information in graphics as it related to written text; future research might do this, as might teachers and students themselves.

A map, which is by nature extensional, might be a good tool for teaching that graphics can extend text. You could choose a map from a textbook and discuss all the information in the map that is not found in the written text. There might be names of states or cities on the map that are not in the written text, for example. There could be a challenge for the students to come up with as many details as possible that appear in the map that do not appear in the written text.

Whereas representational and extensional graphics can be almost any type, or in any category, organizational and interpretational are more specific; the organization function is tied to certain graphic categories, and the interpretation function is tied to a specific type of content. As described above, certain graphics, tables and graphs, are inherently organizational; a photograph or diagram, however, can have almost any function. Because tables and graphs are inherently organizational, there may be no need to teach the concept of organization separately from teaching characteristics of tables and graphs. It may be beneficial to students, in terms of helping them learn how graphics work, to “dissect” tables and graphs by talking about the kind of information shown in them and how that information differs from the information in written text. Discussing what the graphic is able to do, that is, organize information in a way that the written text cannot, may have the combined effect of helping students understand how a table or graph functions as well as perhaps increasing their comprehension of the graphic’s content information.

Interpretational graphics, if you recall, show concrete examples of abstract scientific concepts. They are rare (less than 1%) and it is likely to be more important for a reader to comprehend an interpretational graphic—to see that, for example, the feather and the anvil falling at the same rate are showing gravity (or mass)—than it is for a reader to understand, conceptually, what the graphic is doing. It might be possible to use the interpretational nature of a graphic to teach the content, however. You might want to discuss an example shown in an interpretive graphic with your students and ask if they can think—or draw a picture—of another example. For example, you might ask if they can think of another way to illustrate gravity other than with a feather and an anvil.

The vast majority of graphics are images and simple photographs

There are many types of graphics in informational texts aimed at second- and third-graders, but the overwhelming majority of them are simple photographs and other images. While there are many ways to interpret and utilize this information, it may make sense to begin graphics instruction with the most common graphics! Simple photographs are, of course, the simplest, most basic, graphic type and so ubiquitous that students are likely already familiar with them. However, as Duke et al.’s research indicates, students may not always be able to ascertain what is most important in them and teachers may need to help students learn to do this. In the images category, some graphic types are just a little more involved. Realistic illustrations are closest to photographs, while cartoon illustrations show information in a non-literal way, which a reader must understand in order to comprehend the graphic. Similarly, a reader must know what “magnified” means in order to interpret a magnified image, and that a logo is a symbol for something. (Table 2.2 has descriptions and visual examples of these graphic types.) When readers have learned to comprehend these graphics, they will have learned to comprehend 90% of graphics in informational texts.

There is, however, the other 10%, which may have the most impact on reading comprehension (Carney & Levin, 2002). There are six major categories beyond simple photographs and other images—diagrams, flow diagrams, graphs, timelines, maps, and tables—and each of these has many varieties. Rather than teaching multiple types of these variations to start, it may make more sense to begin with the properties of each category. By learning these properties, students may be able to understand what graphics in this category are intended to do. So, in practice, rather than teaching flow maps, route maps, landmark maps, and topographical maps, it may be more effective to teach students that maps, as a category, show spatial connections and geographical information of all kinds and should be read to glean that information.

Another potential issue is that, because many of these graphic types were very rare in this sample of science and social studies texts for second- and third-graders—even some of the *categories* are rare—children may not get enough exposure to them from informational texts alone. Supplementing graphics may be necessary for students to practice with, and learn to read, them. You can find supplemental graphics in content area books for adults as well as for children and many graphics can be found on educational websites. Generally speaking, books and websites on science topics will have more diagrams, while those on social studies will have more maps and timelines. You can find many types of graphs and tables in math textbooks. When supplementing graphics, choose them carefully: base your choices on what best supports your content (e.g., diagrams for science, timelines for social studies, maps for both) in an ongoing way. In other words, rather than teaching graphics in isolation, make them part of the strategy instruction—how to read graphics—that is already woven through language arts and content areas (Shanahan, Callison, Carriere, Duke, Pearson, Schatschneier, & Torgeson, 2010). The suggestions offered in this article are not intended to take away from other types of literacy instruction, but to enrich the literacy instruction already in place.

Concluding Thoughts

Graphics are ubiquitous in informational texts for children, they can help students' reading comprehension, and the *Common Core State Standards* includes benchmarks for students' ability to understand and use graphics in conjunction with written text. This manuscript has described the ways that 1) graphics have different functions in text, 2) there are many types of graphics in science and social studies texts for second- and third-graders, 3) most graphics in these texts represent and extend text, and 4) most graphics in these texts are photographs and other images. These findings may boost teachers' awareness of graphics and their potential impact on reading comprehension, which may, in turn, lead to enhanced instruction and learning of graphical literacy.

“Take Action!”

- Meet with other teachers in your school to discuss the common typology of graphics and ways you can use these terms with each other and introduce them to your students.
- Once you are familiar with the typology, discuss your priorities in terms of which graphic types and categories to teach and in what grades. Look to the Common Core State Standards, your state’s standards if they differ from the Common Core, and your district’s curricula as guides.
- Look, also, to the graphical demands of the texts in your classrooms. Notice how they differ by book type (textbooks and little books, for example) and content area (science and social studies, for example).
- Address, with your students, that some graphics represent written text while others extend written text. When you are reading graphics together, notice if graphics contain information not found in written text.
- Get students thinking about how graphics work. Have them *name* the graphic (according to the typology you have established), *describe* the graphic in terms of what information it contains, and then *explain* how the graphic shows the information.

Pause and Ponder

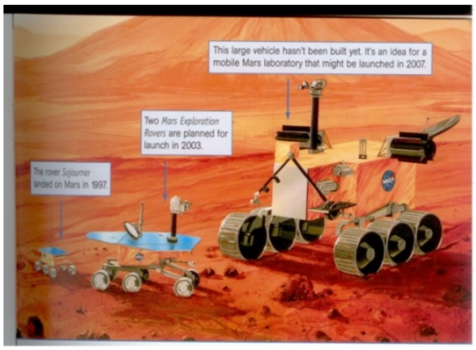
1. In what ways do you use graphics during literacy instruction? Are there certain graphics you feature in reading or instruction? How do you feature them?
2. In what ways do your students interact with graphics when they read? Do different types of readers use them differently? Do your students notice when information appears in a graphic but not in written text?
3. Think about the ways in which you and your students use graphics in different domains. Do you integrate graphics in the same ways and to the same extent during science and social studies? Do your students utilize the graphics more effectively in one domain or another? There is a recommendation in "Take Action" to notice the differences in graphic types and functions in science and social studies texts. How does your instruction and your students' reading relate to these differences?
4. Can you think of some new ways to use graphics to support your instruction, either during literacy blocks or in the content areas?

Most Common 24 Graphic Types, in Order of Frequency, with Descriptions and Examples

Figure 2.1 Photograph

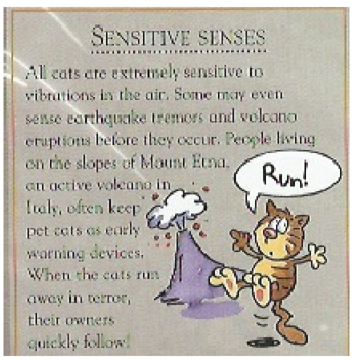
This is a photograph that is not also another graphic type (Capaccio, 2007, p. 12). For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this dissertation. The text is not meant to be readable but is for visual reference only.

Figure 2.2 Realistic Illustration



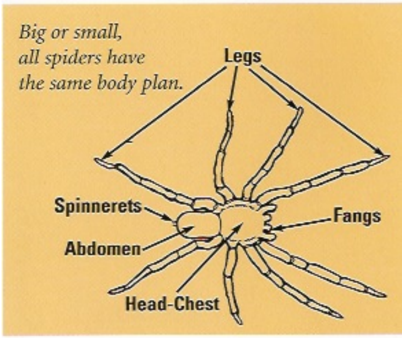
A realistic illustration is a true-to-life, or literal, non-photograph; it can be, for example, a hand-drawing, computer graphic, painting (Getz, p. 21, 2002). The text is not meant to be readable but is for visual reference only.

Figure 2.3 Cartoon Illustration



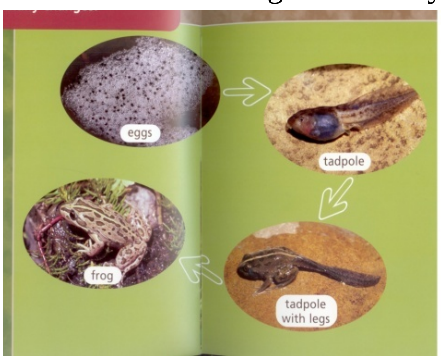
An illustration shows information in a non-literal, sometimes humorous, way; a cartoon illustration can contain true information (Walker, 2002, p. 13). The text is not meant to be readable but is for visual reference only.

Figure 2.4 Simple Diagram



A simple diagram is an image with labeled parts indicated by line and/or arrow (Markle, 2004, p. 3). The text is not meant to be readable but is for visual reference only.

Figure 2.5 Flow Diagram with Cyclical Sequence



A series of images that form a single sequence; the sequence can "flow" in both directions, either direction, or only one direction; this type of flow diagram need not close its loop to be considered cyclical (Yu, 2003, p. 14-15). The text is not meant to be readable but is for visual reference only.

Figure 2.6 Bird's Eye View

A bird's eye view is typically a landscape-type image viewed from above; can be an illustration or photograph (Gillespie, 2010, p. 4). The text is not meant to be readable but is for visual reference only.

Figure 2.7 Simple Map

A simple map shows only geographic information (Rothman, 2000, p. 10-11). The text is not meant to be readable but is for visual reference only.

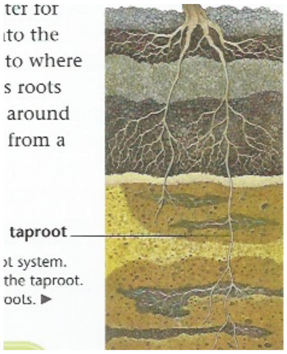
Figure 2.8 Scale Diagram with Picture Units

A scale diagram with picture units compare two (or more) objects to show scale of size (Badders, Bethel, Fu, Peck, Sumners, & Valentino, 2003, 2003, p. B10). The text is not meant to be readable but is for visual reference only.

Figure 2.9 Pictorial Timeline

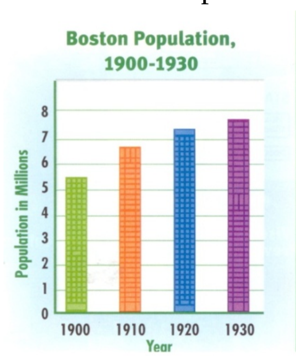
A pictorial timeline is a line with events plotted along it in chronological order with illustrations of one or more of its time-points (Viola, Jennings, Bednarz, Schug, & Cortes, 2008, p. 274). The text is not meant to be readable but is for visual reference only.

Figure 2.10 Cross Section Diagram



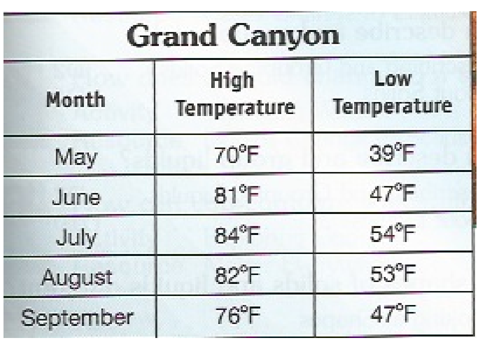
A cross-section diagram is an image of something that is bisected, showing a two-dimensional internal view (Newell, 2005, p. 11). The text is not meant to be readable but is for visual reference only.

Figure 2.11 Bar Graph



A bar graph uses bars to illustrate quantity (Banks, Collearly, Greenow, Parker, Schell, & Zike, 2009, p. 85). The text is not meant to be readable but is for visual reference only.

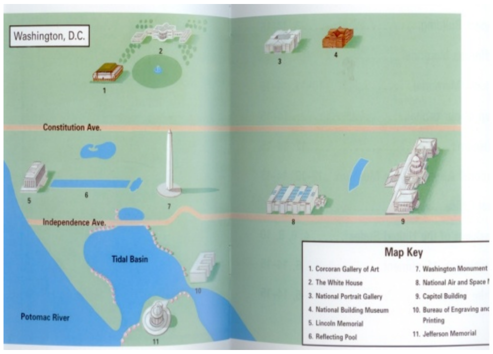
Figure 2.12 Row and Column Table



Grand Canyon		
Month	High Temperature	Low Temperature
May	70°F	39°F
June	81°F	47°F
July	84°F	54°F
August	82°F	53°F
September	76°F	47°F

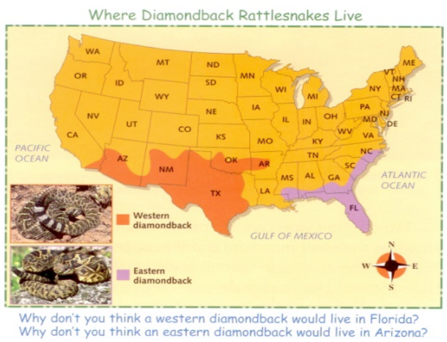
A row and column table organizes information horizontally and vertically in rows and columns (Badders et al., 2003, p. C51). The text is not meant to be readable but is for visual reference only.

Figure 2.13 Landmark Map



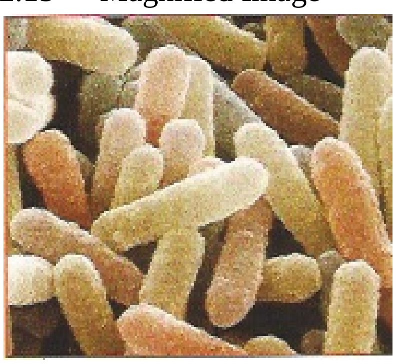
A landmark map shows points of interest (not necessarily landmarks) (Goldish, 2001, p. 14-15). The text is not meant to be readable but is for visual reference only.

Figure 2.14 Region Map



A region map shows characteristics of one or more regions (such as habitat or industry) (Catala, 2002, p. 15). The text is not meant to be readable but is for visual reference only.

Figure 2.15 Magnified Image

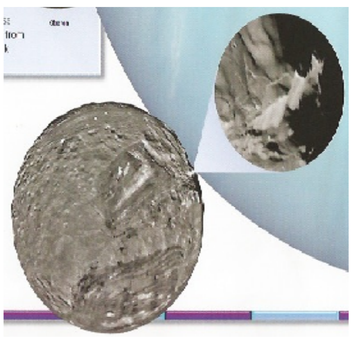


A magnified image is not merely an enlargement, but is an image magnified by a microscope because it cannot be seen by the naked eye; can be a photograph or illustration (Griffel, 2002, p. 11). The text is not meant to be readable but is for visual reference only.

Figure 2.16 Cross Section Photograph/Illustration Hybrid

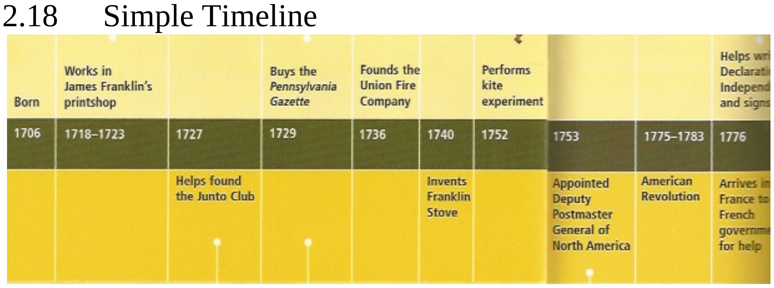
A cross-section photograph/illustration hybrid is when part of the graphic is a "regular" illustration or photograph and part of it is a cross section (Jacobs, 2007, p. 11). The text is not meant to be readable but is for visual reference only.

Figure 2.17 Photograph with Inset



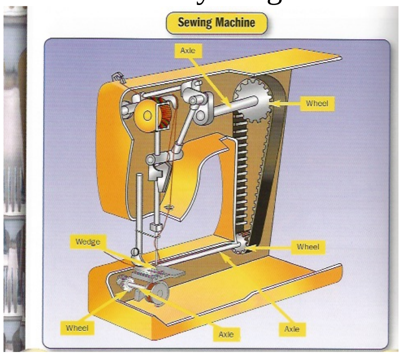
A photograph with inset is a photograph with a small section magnified to show detail (Garlick, 2007, p. 36). The text is not meant to be readable but is for visual reference only.

Figure 2.18 Simple Timeline



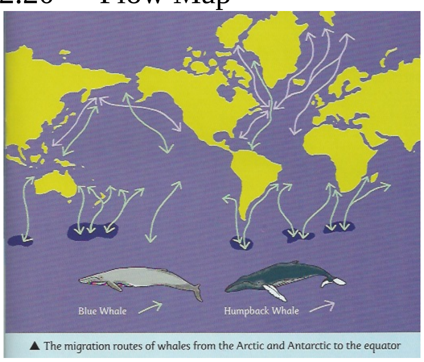
A simple timeline is a line with events plotted along it in chronological order (Rushby, 2004, p. 20-21). The text is not meant to be readable but is for visual reference only.

Figure 2.19 Cutaway Diagram



A cutaway diagram is a three-dimensional object with its surface “peeled” off, which retains three-dimensionality in graphic (Snow, 2005, p. 18). The text is not meant to be readable but is for visual reference only.

Figure 2.20 Flow Map



A flow map is a map that shows movement (Feely, 2010, p. 7). The text is not meant to be readable but is for visual reference only.

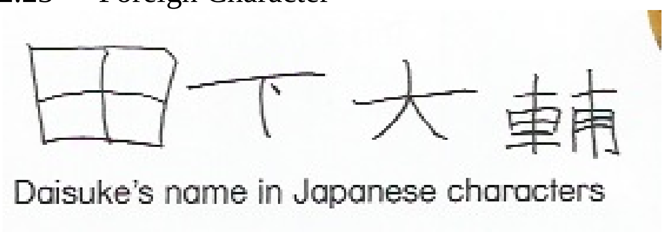
Figure 2.21 Logo

A logo is an emblem or symbol of a company, establishment, or institution, or organization (Banks, Colleary, Greenow, Parker, Schell, & Zike, 2009, p. 3). The text is not meant to be readable but is for visual reference only.

Figure 2.22 Map with Inset

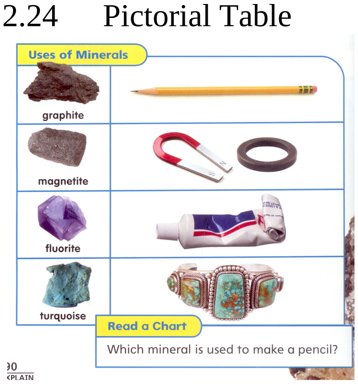
A map with inset is a map with a section enlarged to show greater detail (Graves, 2005, p. 4). The text is not meant to be readable but is for visual reference only.

Figure 2.23 Foreign Character



A foreign character graphic is letters or characters from a foreign language (particularly one that does not use Latin script) that is used for illustration, not communication (Clyne, Griffiths, & Benjamin, 2005, p. 14). The text is not meant to be readable but is for visual reference only.

Figure 2.24 Pictorial Table



A pictorial table is a table (please see "row and column table" category above) in which the data is shown in pictures rather than words (Hackett, Moyer, Vasquez, Teferi, Zike, LeRoy, Terman, & Wheeler, 2008, p. 190). The text is not meant to be readable but is for visual reference only.

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APPENDICES

APPENDIX A: *Crosstab Tables with Chi Square Values*

Table A.1

Crosstabs of Graphic Categories (No Timelines) by Book Type

Graphic Category (No Timelines)		Book Type: Textbook	Little Book	Trade Book	Total
Diagrams	Count	152	144	593	889
	Expected Count	163.8	240.3	484.8	889.0
	% within Graphic Category	17.1%	16.2%	66.7%	100%
	% within Book Type	6.8%	4.4%	8.9%	7.3%
Flow Diagrams	Count	80	48	111	239
	Expected Count	44.0	64.6	130.3	239.0
	% within Graphic Category	33.5%	20.1%	46.4%	100%
	% within Book Type	3.6%	1.5%	1.7%	2.0%
Graphs	Count	10	15	53	78
	Expected Count	14.4	21.1	42.5	78.0
	% within Graphic Category	12.8%	19.2%	67.9%	100%
	% within Book Type	0.4%	0.5%	0.8%	0.6%
Maps	Count	100	98	154	352
	Expected Count	64.9	95.2	192.0	352.0
	% within Graphic Category	28.4%	27.8%	43.8%	100%
	% within Book Type	4.4%	3.0%	2.3%	2.9%
Tables	Count	35	29	20	84
	Expected Count	15.5	22.7	45.8	84.0
	% within Graphic Category	41.7%	34.5%	23.8%	100%
	% within Book Type	1.6%	0.9%	0.3%	0.7%
Images	Count	361	307	3340	4008
	Expected Count	738.7	1083.4	2185.9	4008.0
	% within Graphic	9.0%	7.7%	83.3%	100%

	Category				
	% within Book Type	16.0%	9.3%	50.2%	32.8%
Simple Photographs	Count	1512	2659	2387	6558
	Expected Count	1208.7	1772.7	3576.6	6558.0
	% within Graphic Category	23.1%	40.5%	36.4%	100.0%
	% within Book Type	67.2%	80.6%	35.9%	53.7%
Total	Count	2250	3300	6658	12208
	Expected Count	2250.0	3300.0	6658.0	12208.0
	% within Graphic Category	18.4%	27.0%	54.5%	100.0%
	% within Book Type	100.0%	100.0%	100.0%	100.0%

X^2 (12, N=12,208) = 2447.007, $p<0.001$, Cramer's V=0.32

Table A.2

Crosstabs of Graphic Functions (No Organization or Transformation) by Book Type

Graphic Function (No Organization or Transformation)		Book Type			Total
		Textbook	Little Book	Trade Book	
Decoration	Count	95	145	332	572
	Expected Count	105.5	154.5	312.1	572.0
	% within Graphic Function	16.6%	25.3%	58.0%	100%
	% within Book Type	4.2%	4.4%	5.0%	4.7%
Representation	Count	483	1307	2096	3886
	Expected Count	716.5	1049.4	2120.1	3886.0
	% within Graphic Function	12.4%	33.6%	53.9%	100%
	% within Book Type	21.4%	39.6%	31.4%	31.8%
Interpretation	Count	222	179	23	424
	Expected Count	78.2	114.5	231.3	424.0
	% within Graphic Function	52.4%	42.2%	5.4%	100%
	% within Book Type	9.9%	5.4%	0.3%	3.5%
Extension	Count	1453	1669	4216	7338
	Expected Count	1352.9	1981.6	4003.5	7338.0
	% within Graphic Function	19.8%	22.7%	57.5%	100%
	% within Book Type	64.5%	50.6%	63.2%	60.0%
Total	Count	2253	3300	6667	12220
	Expected Count	2253.0	3300.0	6667.0	12220
	% within Graphic Function	18.4%	27.0%	54.6%	100.0%
	% within Book Type	100%	100%	100%	100.0%

X^2 (6, N=12,220) = 699.042, p<0.001, Cramer's V=0.17

Table A.3

Crosstabs of Representation, Extension, and Other Functions Combined, by Book Type

Graphic Function		Book Type			Total
		Textbook	Little Book	Trade Book	
Other Functions	Count	329	327	358	1014
	Expected Count	187.7	273.7	552.7	1014.0
	% within Book Type	14.5%	9.9%	5.4%	8.3%
Representation	Count	483	1307	2096	3886
	Expected Count	719.2	1048.8	2118.0	3886.0
	% within Book Type	21.3%	39.6%	31.4%	31.8%
Extension	Count	1453	1669	4216	7338
	Expected Count	1358.1	1980.5	3999.4	7338.0
	% within Book Type	64.2%	50.5%	63.2%	60.0%
Total	Count	2265	3303	6670	12238
	Expected Count	2265.0	3303.0	6670.0	12238.0
	% within Book Type	100%	100%	100%	100%

X^2 (4, N=12,238) = 394.104, p<0.001, Cramer's V=0.13

Table A.4

Crosstabs of Representation, Extension, and Other Functions Combined, by Domain

Graphic Function		Domain		Total
		Science	Social Studies	
Other Functions	Count	743	271	1014
	Expected Count	647.2	366.8	1014.0
	% within Book Topic	9.5%	6.1%	8.3%
Representation	Count	2303	1583	3886
	Expected Count	2480.3	1405.7	3886.0
	% within Book Topic	29.5%	35.8%	31.8%
Extension	Count	4765	2573	7338
	Expected Count	4683.5	2654.5	7338.0
	% within Book Topic	61.0%	58.1%	60.0%
Total	Count	7811	4427	12238
	Expected Count	7811.0	4427.0	12238.0
	% within Book Topic	100%	100%	100%

X^2 (2, N=12,238) = 78.148, p<0.001, Cramer's V=0.08

Table A.5

Crosstabs of Representation, Extension, and Other Functions Combined, by Grade Level

Graphic Function			Book Grade Level		Total
			Second Grade	Third Grade	
	Other Functions	Count	285	371	656
		Expected Count	269.1	386.9	656.0
		% within Book Grade Level	12.5%	11.3%	11.8%
	Representation	Count	850	940	1790
		Expected Count	734.3	1055.7	1790.0
		% within Book Grade Level	37.2%	28.6%	32.1%
	Extension	Count	1149	1973	3122
		Expected Count	1280.6	1841.4	3122.0
		% within Book Grade Level	50.3%	60.1%	56.1%
Total		Count	2284	3284	5568
		Expected Count	2284.0	3284.0	5568.0
		% within Book Grade Level	100%	100%	100%

X^2 (2, N=5568) = 55.472, $p<0.001$, Cramer's V=0.10

Appendix B: *Description of the Coding Manual*

Introduction

In the Excel spreadsheets used for data collection and entry, each row corresponds to one graphic. For each graphic, there are fifteen data points, which appear in columns A-N. The coding manual is 59 pages and is divided into sections A-N, which correspond to the columns in the Excel spreadsheet. Each section includes a brief definition and/or description of the type of data in that column, general guidelines for coding, and written and visual examples for each code. In some cases, multiple examples are provided along with detailed instructions for correct coding. Sections A-F and G-N describe two different types of data. The data described in G-N pertains to the texts the graphics are found in; this information is the same for every graphic in a particular text. The data in A-F describes each graphic discretely.

Text-Related Data (Description of Coding Manual Sections G – N)

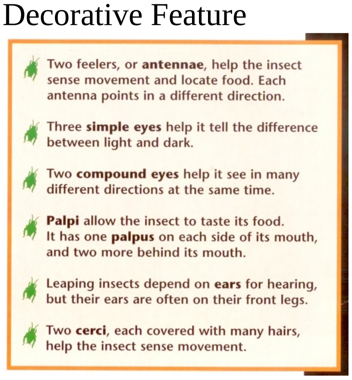
This includes the book type (G), topic (H), grade (I), publisher (J), title (K), author (L), number of pages coded (M), and total number of graphics (N). Section M, the number of pages coded, includes information on which pages are coded and which pages are omitted. The following is an entry about what to omit.

> Do not count or code appendices, indexes, or glossaries. These may be marked, as in textbooks, but an appendix-like table or chart may also appear at the end in little books after the main body of text concludes. Do not code a table or chart like this. Typically, the images on one of these pages will be repeated from the main body of text, but not always. Either way, do not code the graphic or count the page. (p. 49)

Section N, total number of graphics, describes how to determine what constitutes a graphic (as opposed to, for example, a decorative border) and what constitutes "one graphic." The following entry describes a decorative feature that is not coded:

> In the following example, these are insect-shaped bullet points. They contain no information, they are 100% decorative, they are not coded:

Figure A.1
Decorative Feature



Two feelers, or **antennae**, help the insect sense movement and locate food. Each antenna points in a different direction.

Three **simple eyes** help it tell the difference between light and dark.

Two **compound eyes** help it see in many different directions at the same time.

Palpi allow the insect to taste its food. It has one **palpus** on each side of its mouth, and two more behind its mouth.

Leaping insects depend on **ears** for hearing, but their ears are often on their front legs.

Two **cerci**, each covered with many hairs, help the insect sense movement.

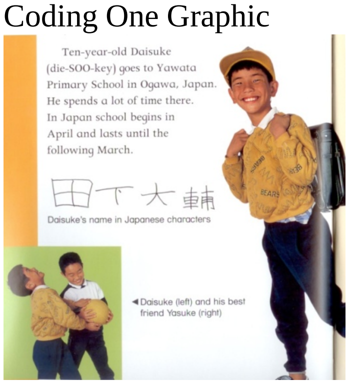
(Jacobs, 2007, p. 8) The text is not meant to be readable but is for visual reference only.

For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this dissertation.

Section M contains fifteen entries about what constitutes one graphic. In Section E, which describes the graphic types, there is some additional type-specific information about what comprises one graphic. Section M contains general information. The following entries describe the function of “white space”:

> White space can be relative so that there may not be a large amount of white space surrounding a graphic relative to the page, but it is enough white space relative to the graphic itself to set it apart from another graphic nearby. In the following example, the four Japanese characters are close enough together that they comprise one graphic in this study. The white space around each Japanese character and between each character is smaller and much less substantial than the white space around the group of Japanese characters, Graphic #1, as a whole. The white space around the group of characters, i.e. around the Graphic #1, clearly sets the characters apart from Graphic #2 (the boy with the backpack) or Graphic #3 (the two boys playing with the basketball.

Figure A.2
Coding One Graphic



(Clyne, Griffiths, & Benjamin, 2005, p. 14) The text is not meant to be readable but is for visual reference only.

Graphic-Specific Data (Description of Coding Manual Sections A – F)

Section A: Page number

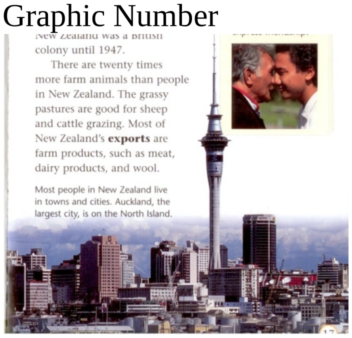
This section refers to the page number where a graphic is located. Typically, this is straightforward. There is information on how to code when a graphic spans two pages or if pages are not numbered.

Section B: Graphic number

This section describes how to number each graphic based on where it appears on a page. Generally, graphics are numbered left to right, top to bottom. There are many specific examples in this section with accompanying explanation. For example, the following entry in the coding manual clarifies a potentially confusing coding situation:

> In the following example, there is a graphic that appears high in the right-hand corner (which might indicate, per the point below, that it could be coded "1" in the left-right, top-bottom system), but in this case the two graphics on the page overlap so that Graphic #1, Auckland, overlaps up against Graphic #2, the two men practicing the Maori welcome.

Figure A.3
Graphic Number

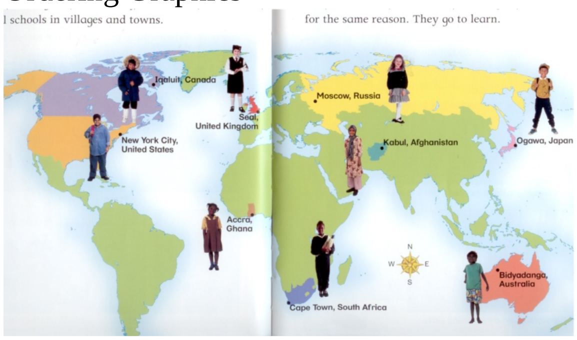


(Sinclair, 2005, p. 17) The text is not meant to be readable but is for visual reference only.

This example of an entry from the coding manual shows the way to number the graphics on a page containing a large number of graphics:

The following example is complicated and shows some of the issues described above so I will show how the graphics would be coded in terms of page and order, i.e. what number each graphic would be on each page, pages 4 and 5:

Figure A.4
Ordering Graphics



(Clyne, et al. 2005, p. 4-5) The text is not meant to be readable but is for visual reference only.

i. The map comes first: page 4, #1
ii. The child from Iqaluit, Canada: p. 4, #2
iii. The child from Seal, UK: p. 4, #3
iv. The child from New York City, US: p. 4, #4
v. The child from Accra, Ghana: p. 4, #3
vi. The child from Moscow, Russia: p. 5, #1
vii. The child from Ogawa, Japan: p. 5, #2
viii. The child from Kabul, Afghanistan: p. 5, #3
ix. The child from Cape Town, South Africa: p. 5, #4
x. The child from Bidyadanga, Australia: p. 5, #5

Section C: caption, label, none

This section describes the differences between captions and labels and how to distinguish between captions and regular text. Captions are sentences and labels are one- or two-word terms;

if a graphic has both, it is coded as having a caption. The following example of an entry from the coding manual shows an example of a type of caption:

> Sometimes it is difficult to tell the difference between a caption and regular text. If text is enclosed in a box with a graphic, it is a caption even if the text is the same size and font as the regular body of text in a passage. In the following example, the caption is not "Event: National Cherry Festival"; that is a title. The caption reads from "Traverse City, Michigan…pie eating contest!":

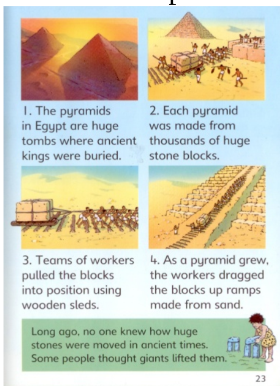
Figure A. 5
Captions and Labels

(Banks, Colleary, Greenow, Parker, Schell, & Zike, 2009, p. 27) The text is not meant to be readable but is for visual reference only.

This entry from the coding manual shows that sometimes a caption can be the only text on a page:

> Sometimes the only text on a page is caption or captions. Even though it's the only text, it doesn't mean it's necessarily "regular" text. It can be confusing because captions might even look like regular text. If the text appears very close to a picture and relates directly, specifically, and exclusively to a graphic, particularly if it is part of a numbered series, the text is caption instead of regular text. In the example below, the text around the first four graphics are captions, not regular text. See how the language of the text relates to the images; the text is captioning each image. There simply is no regular text on the page. (The fifth graphic is more obviously captioned.)

Figure A.6
Extended Captions



(Gillespie, 2010, p. 5) The text is not meant to be readable but is for visual reference only.

Section D: photograph/illustration

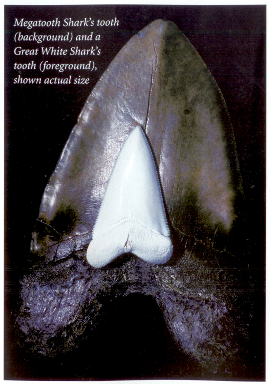
This section of the coding manual explains that each graphic, in addition to a specific type code, is coded as a photograph or illustration. Certain tables (e.g., row and column tables) are neither, N/A.

Section E: graphic type

This section defines and describes every one of the specific graphic-types. More than any other, this section grew over time. Nearly every graphic type has a visual example and many have multiple visual examples. The following entry from the coding manual shows scale diagrams with picture units:

> Scale diagram with picture units of measurement: SDP (this is when two objects are compared to show scale of size.) The following examples are pretty straightforward. Note: a SDP may also contain conventional units of measurement, as in the second example:

Figure A.7
Graphic Type Example: Scale Diagram with Picture Units



(Markle, 2008, p. 8) The text is not meant to be readable but is for visual reference only.

Figure A.8
Graphic Type Example: Scale Diagram with Picture Units 2

(Badders, Bethel, Fu, Peck, Sumners, & Valentino, 2003, p. B10) The text is not meant to be readable but is for visual reference only.

This entry shows an example of a graphic that looks like a certain type, but is not.

Note: not all insets are "insets": sometimes a small graphic appears within or near a larger one, but is not an actual enlargement of part of the larger graphic. Sometimes it's just a smaller, related graphic.

In the following example, the photograph of Len is not an inset. It's a related graphic.

Figure A.9
Graphic Type Example: Simple Map

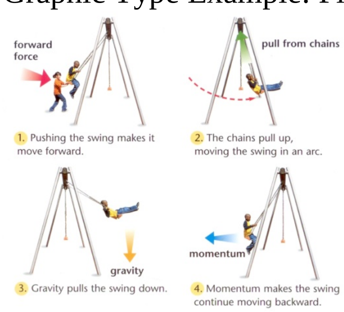
(Viola, Jennings, Bednarz, Schug, & Cortes, 2008, p. 67) The text is not meant to be readable but is for visual reference only.

In general, a photograph that’s “blown up” out of a map is *not* an inset.

This entry from the coding manual, of a flow diagram with cyclical sequence, explains why it is one graphic, not four:

The following example is complicated because each of the four stages of the diagram could easily stand alone. This is frequently the case with flow diagrams, as it is with the example in i above with the life cycle of the frog, but it is the four stages together that comprise the flow diagram. The following is a close call, but the parts belong to a greater whole, so code all four images as one graphic, FDCS:

Figure A.10
Graphic Type Example: Flow Diagram with Cyclical Sequence

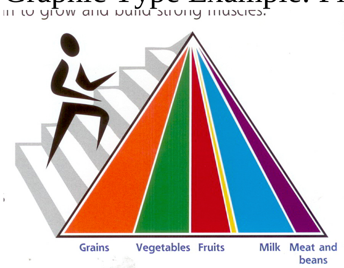


(Paren, 2005, p. 11) The text is not meant to be readable but is for visual reference only.

This entry describes an unusual variation on a common graphic type:

A pie chart does not need to be a circle. The following example is shaped like a pyramid, but the depiction of information is the same as the regular pie chart above. In fact, the information itself is also the same: these charts are from the same book and show the information in different contexts on different pages.

Figure A.11
Graphic Type Example: Pie Chart



(Kudlinski, 2002, p. 6) The text is not meant to be readable but is for visual reference only.

Section F: graphic function

This section of the coding manual defines and describes the six graphic functions. In this section, there is a lot of written description and distinction. There are also visual examples, but because the functions are conceptual, the written entries are more detailed than in some of the other sections. This example of an entry from the coding manual describes the way captions function in representational graphics:

> One tricky thing is that, to be "representation," the graphic must show what is in the regular text, not a caption. A caption describes a graphic and, in effect, comes after the fact. In coding this category of function, we're looking at how a graphic relates to the regular text.
>
> > If a caption repeats information found in the regular text and adds *nothing new*, then the graphic is coded "2".

If, however, there is a name of an animal in the photograph that isn't named in the regular text or any other additional information, the graphic is coded "2".

This entry from the coding manual shows an example of an interpretational graphic:

In the following example, the graphic shows "force." It is impossible to show force in the abstract, so the graphic shows the flags, which appear to be waving, and the caption explains the rest:

Figure A.12
Interpretational Graphic

(Harcourt, 2004, p. 8) The text is not meant to be readable but is for visual reference only.

This entry from the coding manual explains why maps are always coded as extensional:

Maps are always coded for extension, even if the map adds no new textual information and only illustrates information, even the "exact" information (as in #2, Representation, above) found in the regular text. Unlike a photograph, every map, no matter how simple, contains geographic information that is discrete from the text and requires skill and knowledge to comprehend.

Closing

This concludes my description of the coding manual. Again, the complete manual is 59 pages in length. It is available from me upon request.

REFERENCES

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