Journal of Visual Literacy, Autumn 2004
Volume 24, Number 2, pp. 185-204

Instructional Illustrations: Intended Meanings and Learner Interpretations

Elizabeth Boling, M.F.A.
Indiana University
Bloomington, Indiana, U.S.A.

Malinda Eccarius, Ph.D.
University of Nebraska Lincoln
Lincoln, Nebraska, U.S.A.

Kennon Smith, Doctoral Student
Indiana University
Bloomington, Indiana, U.S.A.

Ted Frick, Ph.D.
Indiana University
Bloomington, Indiana, U.S.A.

Abstract

Instructional illustrations are widely used in textbooks and have been shown to have the potential to aid learning. However, illustrations that are not understood as their designers intend them to be may waste resources at best and interfere with learning at worst. Learners may recognize images but not understand illustrations when their meanings are extended by the use of graphical devices. This study examines the interpretations made by 471 participants from 2 countries, 3rd grade through adult, of simple instructional illustrations. The extent to which their interpretations match the intended meanings of the illustration designers and the characteristics of their responses are reported.

Illustrations are widely used in instructional materials. For example, Evans, Watson, and Willows (1987), in their review of more than sixty Canadian reading, math, and science textbooks published between 1977 and 1982, found that illustrations (including photographs, diagrams, maps, and drawings) accounted for 60 to 80 percent of the page space in some elementary texts.

While the frequency of illustrations in these texts declined as the grade level increased, the authors reported that in the sampled junior high texts 30 to 60 percent of page space was devoted to illustrations. Petersson (2002) reports that "one-third to one-half of the space in science textbooks is devoted to illustrations" (p. 245), and goes on to say that Berglund (1991) "verified that for each generation the pictures of the textbooks have become more in number, larger, more elegant, and more colourful" (p. 246).

Instructional Illustrations

In this study, we are addressing a specific type, or sub-category of instructional illustration. Specifically, we are dealing with illustrations that have the following two characteristics: (1) the image includes some pictorial or representational form(s), and (2) those pictorial elements are augmented by graphical devices or elements intended to extend the meaning beyond that which can be shown by literal, visual representation. These characteristics appear in the illustration in Figure 1.

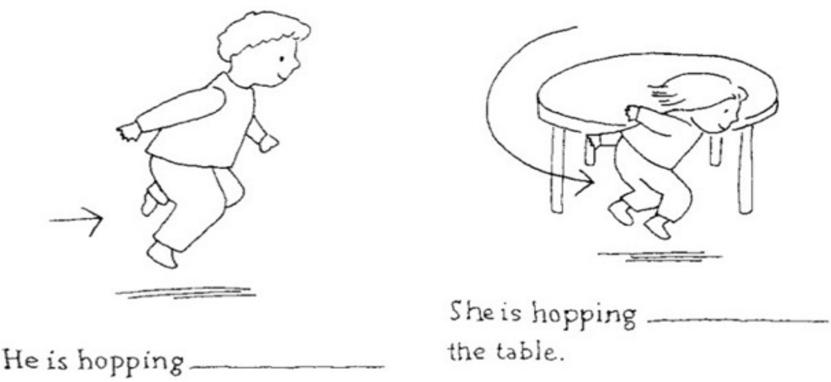

Figure 1. Drawn from Grade 2 *Literacy Place* ESL/ELD Workbook, Scholastic, 2000. In this example, the child fills in the appropriate words according to the extended meanings indicated by the arrows.

This image includes recognizable drawings or pictures of things, including the two children and their physical postures, as well as the table in the second image. These are representations of what we would expect to see if we were watching the scene in "real life." The arrows, on the other hand, would not be visible in the scene if we were watching real children hopping. They are devices added to the otherwise pictorial elements of the image.

Graphical Devices That Extend Meaning

These illustrations also include non-pictorial elements of a type often used by illustrators to extend and clarify the meaning of pictorial context. These devices serve as a useful shorthand method for representing phenomena such as thought, speech, or past or future action, which are not visually evident when viewing a scene (McCloud, 1994; Eisner, 1985). Due to their static, spatial, two-dimensional format, pictorial illustrations do not readily lend themselves to the literal replication of these experiences. Both common visual conventions and ad hoc use of non-pictorial elements are used to represent such phenomena both in the popular media (cartoons, animations, video and computer games) and in instructional illustrations (Evamy, 2003). In Figure 1, these devices include the straight arrow in the first image, and the curved arrow in the second. These devices indicate the direction and path of motion of the girl and boy depicted. These graphical devices would not be visible if one were viewing the scene in "real life;" they serve to modify or extend the understanding of the actions depicted.

In addition to serving as an example of instructional illustration, Figure 1 also exemplifies the importance of studying pictorial images with graphical elements included to modify or extend their meanings. This type of illustration is used either as source material from which learners are supposed to derive meaning relevant to a lesson, or as explanatory support for concepts that include invisible or intangible components. Despite the potential usefulness of these devices to extend and clarify the meaning of the narrative or informational message intended by the illustrator, recent research has suggested learners may not always interpret, or even attend to, these devices as the designer had intended (Boling, Frick, Sheu & Huang, 2002; Young & Wogalter, 2000/2001). Our current research seeks to understand better the patterns that might exist in the ways that learners use and attend to these types of visual elements.

Potentially Beneficial Effects of Illustrations

Pictorial images have been shown to have potentially beneficial effects in a broad range of settings, and for a variety of types of learning (Anglin, Towers & Levie, 1996). For example, a number of studies have found that memory of text content is enhanced when the text is accompanied by illustrations (see, for example, Mayer, 1989). Additionally, illustrations have demonstrated beneficial effects in helping students learn material as measured by their ability to apply new knowledge to solving novel problems. Mayer (1989) found that learners using labeled illustrations performed significantly better on both recall and problem-solving tasks that learners using text alone, or text accompanied by non-labeled illustrations. Additionally, there is evidence to suggest that illustrations may have positive impact on affect while students are engaged with the instructional materials (Peeck, 1987).

Potentially Harmful Effects of Illustrations

Although the majority of current research supports the usefulness of illustrations in instructional texts, there has been historically some disagreement regarding the efficacy of images in instructional materials. In his 1970 review, Samuels concluded that illustrations had potentially negative effects on learning. This conclusion had significant repercussions in illustration research, and led to confusion regarding the impact of images upon learning (see discussion in Levin, Anglin, and Carney, 1987). Levin, Anglin and Carney have since pointed out that almost all of the studies examined by Samuels dealt specifically with the impact of illustrations upon learning *how to* read (as opposed to learning *from* reading). Numerous scholars have concluded that, when an individual is learning to read, illustrations may interfere with the development of reading skills (Salomon, 1979, as cited in Braden, 1996) and others have shown that illustrated texts can diminish the attention paid to non-illustrated portions of the text (see Peeck, 1987 for summary of findings of Van Dam, Brinkerink-Carlier & Kok, 1987). Peeck (1987) also points out that poor illustrations may actually diminish learner motivation.

These findings should serve as a cautionary reminder that, despite technological developments that have facilitated the inclusion of more, higher-quality illustrations in instructional materials, it is important to make informed decisions regarding the design and appropriate use of such images. Otherwise, they may not only fail to have the intended positive effect, but may, at the very least, constitute wasted resources and page space, and at the worst, interfere with learning processes. Furthermore, Mayer's (1989) study contrasting the efficacy of labeled versus non-labeled illustrations suggests that relatively simple design interventions can significantly affect the usefulness of an instructional illustration. Consequently, it is vital that we better understand how images are being used, and how they can be enhanced in the future.

Theories of Picture Perception

While there is not yet any broad consensus among scholars regarding how images are perceived and used, there are a number of schools of thought that provide frameworks for thinking about and studying these issues (see Anglin, Towers, and Levie (1996) for an overview of theories of picture perception; and Rollins (1999) for a comparison of major theories). One of the themes that has emerged from past research is that while most people in most cultures recognize objects depicted in pictures, they do not necessarily recognize the meaning intended by the creator of the image.

Most People Recognize Pictures of Things

Past research has indicated that most people, in most cultures can recognize pictures of things, or the illustration content (Kennedy, 1994; Sless, 1981). Based on research findings, some have concluded that the ability to recognize objects in pictures may be innate (Levie, 1987). This ability is particularly remarkable because, according to Schapiro:

> Taken out of the image, the parts of the line will be seen as small material components: dashes, curves, dots, which, like the cubes of a mosaic, have no mimetic meaning in themselves. All these assume a value as distinct signs once they enter into certain combinations, and their qualities as marks contribute something to the appearance of the represented object. According to the context of adjoining or neighboring marks, the dot may be a nail-head, a button, or the pupil of an eye; and a semi-circle may be a hill, a cap, an eye-brow, the handle of a pot, or an arch. (1969, p. 238)

People Often Do Not Recognize the Intended Meaning

Despite what appears to be a cross-cultural ability to recognize objects depicted in pictures, the visual content of an illustration is frequently a vehicle used to communicate a more complex meaning or intention. Unlike the subject content of the picture, this intended meaning may often be misunderstood, or unrecognized by the viewer. There have been a number of theories put forward in an attempt to account for this apparent disconnect between intended and interpreted meanings. These theories point to both developmental and cultural factors as influencing an individual's processes in interpreting images.

Consistent with the theories of Piaget, some scholars have suggested that young children interpret visual information very literally, and that they may not be developmentally ready to understand abstract concepts or representations included in illustrations (Higgins, 1980 and Siegel, 1978 as cited by Cooper, 2002). Furthermore, after analysis of numerous studies on children's uses of visual information, Goldsmith (1984) concluded that emphasis on literal interpretation of visual images could interfere with an individual's ability to generalize to a meaning beyond the specific depiction represented in the given illustration, and that the ability to understand complex visuals is a learned capacity.

Additionally, studies across a variety of cultures have suggested that culturally-bound conventions may lead to misunderstandings when an image is exported from one culture to another (Schiffman, 1996 as cited by Cooper, 2002). As pointed out by Levie (1987), the seemingly natural way in which we typically learn to see and understand pictures may lead us to assume that this is an innate ability, and that all individuals read and interpret images consistently with our own understandings. However, beyond their ability to present a visual representation of a given object, visual illustrations do not constitute a universal language. Attempts to create an intuitive, universal language based on visual, non-textual cues, have proven frustrating (Drucker & McGann, 2000/2001). This suggests that images are not automatically interpreted in one way or another, but that our interpretations are often learned, in a way similar to, though perhaps not as explicitly as, language learning. Hagen (1980) describes the process of interpreting visual images by stating:

> "Meaning is not given by the head to the unstructured stimulus, nor is it given by the stimulus to the unstructured head. The relation between the two is reciprocal and symmetrical" p. 45.

Additionally, the field of semiotics has been especially helpful in stressing the importance of social processes in the interpretation of visual images (Harrison, 2003).

Instructional illustrations are usually seen in meaningful contexts which supply cues that might enhance readers' understandings of the illustrations. Schriver (1997) observes that, "Readers use everything in the perceptual field to make their judgments about words and pictures under consideration" (p. 367). However, multiple factors can interfere with the successful use of context to interpret the meaning of an image, and the use of elements within a graphic that are not clear to the viewer is primary among them (Schriver, pp. 372-373). Sless (1981) argues further that students who have not learned the significance of specific graphical elements cannot necessarily be expected even to notice their presence. An element that is not noticed will not be used to aid the successful interpretation of an image.

Purpose of the Study

Initially the purpose of this study was to discover the extent to which various populations interpret the meaning of simple illustrations including graphical devices consistently with the meaning intended by the designer of the illustrations, and to discover something about how individuals were making their interpretations. Following our pilot study we recognized that we had no way to tell whether or not the graphical devices were making a difference in people's interpretations of the images containing them. We expanded the purpose of the study to ask whether or not the presence of graphical devices in instructional illustrations affects the way those illustrations are interpreted. We will report data and analysis relevant to both purposes in this report.

Method

The study included development of an image-based survey, a pilot survey, revision to the images used in the survey and revisions to the study design, followed by administration of the survey to six different populations.

Materials

Based on visual materials produced in clinical classroom by one of the authors we selected common graphical elements and designed a set of 16 very simple images that incorporated those elements. Each image included a graphical device intended to clarify and extend the meaning of the image. The images were designed with the following extensions to their meanings:

1. Movement up and down (jumping, bounding, hopping),
2. Movement back and forth,
3. Speed,
4. Positive feeling of recipient,
5. Path of prior motion with stops at multiple locations,
6. Reference to mental activity (participants could also give reasonable contents of thought bubble),
7. Path of future motion with indication of target,
8. Reference to oral communication (or participants could fill in reasonable content in speech balloons),
9. Activity at the same time but different places,
10. Not / negation,
11. Reference to communication with hands (possible interpretation of sign language hand shapes might be given: sew, Friday, important, finish, one to one, meet, right (correct), agree, nine, family, fix, interpret),
12. Transformation, one thing becomes another,
13. Source of electronic speech (broadcasting, on TV),
14. Looking, line of sight,
15. Movement or meaning of movement (feelings such as happy or excited),
16. Unconscious or dead.

A series of demographic questions and the sixteen images were arranged as a paper-based survey.

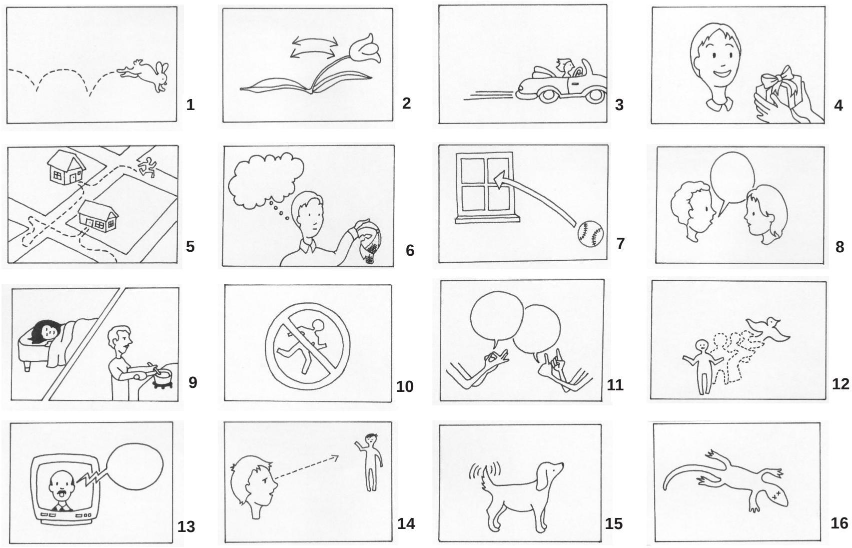

Figure 2. Survey with graphical devices.

After the pilot study, the survey was slightly revised to improve the visual consistency across the survey items. A second survey was also created, which included identical images without the graphical devices (figure 3). This was to allow the researchers to examine whether or not the presence of the graphical elements actually influenced the ways in which participants responded to the items.

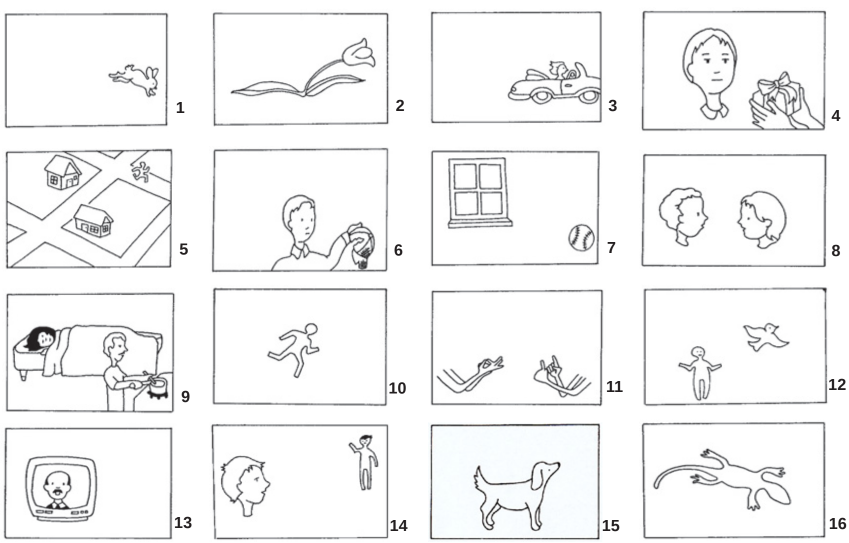

Figure 3. Survey without graphical devices.

Participants

A convenience sample of ninety-six college students in a humanities elective course participated in the pilot study. Following revision of the survey and procedure based on the pilot, 471 participants have participated in the survey. The participants fall into six sample groups: third, sixth and tenth grade students in the United States (U.S.A.), U.S.A. college students, teachers of the deaf and hard of hearing, and college students in Malaysia. The U.S.A. college students were undergraduates in two courses; an elective course in sociology and a required technology course for pre-service teachers. The college students from Malaysia were undergraduates in education courses. The K-12 participants attended schools in mixed income school districts, and came from mixed-ability classrooms. Table 1 summarizes the number of participants per sample group.

Table 1

Number of Participants Per Sample Group

Sample Group	Participants Completing Surveys WITH Graphical Elements	Participants Completing Surveys WITHOUT Graphical elements
Third Graders	38	25
Sixth Graders	46	39
Tenth Graders	26	28
United States College Students	34	39
Malaysia College Students	50	54
Teachers of the Deaf and Hard of Hearing	47	45

The elementary, junior high and high school age participants were included in the study as representative of populations for whom instructional illustrations are commonly produced, and representative of individuals at distinctly different developmental stages in learning. The college students from two countries were selected as representative of young adults from different cultural and language backgrounds. Teachers of the deaf and hard of hearing were included in the study as a population that might be expected to have some experience with using visual methods of communication in teaching.

Procedures

The participants who completed the survey wrote short (usually one sentence) responses for each item, indicating what they believed each illustration meant. The overseas participants were invited to respond in their first language. The Malay participants answered in Bahasa Meayu, English, or both. Their responses were translated into English by a fluent speaker of both languages and were coded by native speakers of English subsequent to translation. One survey from the teacher population was returned in Spanish and translated by a native speaker of Spanish before it was coded. One survey from the 3rd grade population was filled out by a student who was a poor writer. This participant dictated responses to a teacher who wrote them down exactly as spoken.

Data Analysis

The data analysis was conducted in two phases. Phase 1 focused on the extent to which the participants responses matched the designers' intended meanings for the images. Phase 2 focused on understanding more about the interpretations participants made through analyzing their responses directly. As yet we have only examined differences between entire populations; demographic comparisons within populations have not yet been conducted.

Phase 1 Analysis and Results

Each response on each survey was scored as a 1 if it captured the intended meaning of the illustration (matching), and as a 0 if it did not (non-matching). A randomly selected set of 15 surveys from each sample group was coded by a second rater, and inter-rater reliability statistics were calculated to evaluate the consistency of the coding process. The mean of the Kappa values (simple percentage agreement corrected for chance agreement) is .87, with a standard deviation of .17. People trained on the coding scheme agree very consistently in their coding.

Frequencies of matching and not matching responses to each item were calculated for sample groups. Those frequencies are summarized in Tables 2 and 3.

Respondents who did not see the devices answered consistently with designers' intentions less frequently than those who saw the devices, except for the images with redundant cues to meaning (bunny – image 1, fast car – image 3, talking – image 8, sign language – image 11, looking – image 14). Two out of three respondents who saw the devices, matched the designers' intended meaning; one out of five who did *not* see the devices matched the designer's intended meaning.

Table 2

Frequency of Participant Responses Matching Designer's Intended Meaning. Surveys WITH Graphical Devices

#	Description	3rd Grade n=38	6th Grade n=46	10th Grade n=26	U.S.A. College n=34	Malaysia College n=50	Teachers n=47
1	Bunny	0.87	0.83	0.85	0.74	0.66	0.98
2	Flower	0.13	0.28	0.19	0.38	0.34	0.47
3	Car	0.58	0.74	0.85	0.74	0.72	0.72
4	Gift	0.18	0.44	0.38	0.24	0.52	0.43
5	Running Guy	0.13	0.26	0.38	0.21	0.10	0.45
6	Hat	0.40	0.56	0.65	0.82	0.66	0.85
7	Baseball	0.50	0.59	0.62	0.56	0.22	0.72
8	Talking	0.97	0.98	0.96	0.94	0.78	1.00
9	Sleep/Cook	0.03	0.02	0.00	0.00	0.00	0.00
10	No Running	0.79	0.94	1.00	1.00	0.94	1.00
11	Signing	0.58	0.67	0.81	0.71	0.38	0.89
12	Transformation	0.71	0.89	0.81	0.65	0.18	0.47
13	TV	0.40	0.61	0.69	0.76	0.44	0.83
14	Looking	0.79	0.85	0.85	0.91	0.64	0.94
15	Dog	0.90	0.83	0.88	0.82	0.58	0.94
16	Lizard	0.63	0.80	0.81	0.68	0.42	0.53

Table 3

Frequency of Participant Responses Matching Designer's Intended Meaning. Surveys WITHOUT Graphical Devices.

#	Description	3rd Grade n=25	6th Grade n=39	10th Grade n=28	U.S.A. College n=39	Malaysia College n=54	Teachers n=45
1	Bunny	0.80	0.85	0.86	0.77	0.44	0.96
2	Flower	0.04	0.00	0.00	0.00	0.00	0.02
3	Car	0.16	0.36	0.18	0.13	0.26	0.24
4	Gift	0.00	0.00	0.00	0.00	0.04	0.00
5	Running Guy	0.00	0.00	0.00	0.00	0.00	0.00
6	Hat	0.16	0.00	0.00	0.08	0.15	0.07
7	Baseball	0.36	0.46	0.79	0.62	0.13	0.69
8	Talking	0.40	0.49	0.75	0.82	0.54	0.87
9	Sleep/Cook	0.00	0.00	0.00	0.00	0.00	0.00
10	No Running	0.00	0.00	0.00	0.00	0.02	0.02
11	Signing	0.52	0.72	0.61	0.80	0.57	0.96
12	Transformation	0.00	0.00	0.00	0.00	0.00	0.00
13	TV	0.20	0.18	0.18	0.15	0.18	0.33
14	Looking	0.04	0.13	0.18	0.23	0.13	0.29
15	Dog	0.00	0.00	0.07	0.00	0.04	0.02
16	Lizard	0.08	0.13	0.14	0.05	0.18	0.09

Only two images were interpreted correctly at 80% or above across populations (verbal communication – image 8, and no running – image 10). 10th graders interpreted 9 of 16 pictures consistently with the designers' intentions at 80% or above; teachers of the deaf interpreted 8 out of 16 pictures this way. In all other populations fewer than half the pictures were interpreted correctly at 80% or above.

For any given item the frequency counts show which sample groups interpreted the meaning of the item more consistently with the designer's intention than other groups, but these frequency statistics do not indicate whether or not the observed differences are statistically significant. Because the data violate the homogeneity of variance assumption, standard ANOVA procedures could not be used to compare how different groups responded to any particular image. In order to minimize the likelihood of creating type 1 errors in the process of making multiple comparisons, the researchers adopted a conservative alpha level for the comparisons drawn on each item. For each item, an overall alpha level of .05 was selected. Then, since four comparisons were being made, this alpha level was divided by four, resulting in an alpha of .0125 for each of the four pair-wise comparisons per item. Consequently, no single comparison is identified as being statistically significant unless it results an alpha of < .0125.

The four pair-wise comparisons conducted were as follows:

- Third grade students and tenth grade students
- Third grade students and U.S.A. college students
- U.S.A. college students and Malay college students
- U.S.A. college students and teachers of the deaf

These specific comparisons were selected in order to observe whether there seemed to be systematic differences based on development and maturity (such as the comparisons of third graders vs. tenth graders, and third graders vs. U.S.A. college students), native language and culture (U.S.A. college students vs. Malay college students), or exposure to visual images as primary communication tools (U.S.A. college students vs. teachers of the deaf).

The comparisons yielding statistically significant differences are identified in table 4 with an asterisk. The comparisons yielding the greatest number of statistically significant differences were those drawn between U.S.A. college students and Malay college students.

Table 4
Between Group Comparisons

#	Description	3rd Grade & 10th Grade Students	3rd Grade & U.S. College Students	U.S.A. College & Malay College Students	U.S.A. College & Teachers of Deaf
1	Bunny	0.244	1.404	0.736	-3.055*
2	Flower	-0.630	-2.478	0.391	-0.765
3	Car	-2.460	-1.399	0.153	0.117
4	Gift	-1.723	-0.524	-2.772*	-1.833
5	Running Guy	-2.258	-0.829	1.285	-2.371
6	Hat	-2.081	-4.114*	1.725	-0.325
7	Baseball	-0.906	-0.493	3.235*	-1.514
8	Talking	0.261	0.668	2.239	-1.436
9	Sleep/Cook	1.000	1.000	*****	*****
10	No Running	-3.141*	-3.141*	1.769	*****
11	Signing	-2.022	-1.118	3.093*	-2.054
12	Transformation	-0.896	0.568	4.686*	1.612
13	Tv	-2.431	-3.390*	3.172*	-0.705
14	Looking	-0.576	-1.469	3.216*	-0.399
15	Dog	0.124	0.854	2.515*	-1.492
16	Lizard	-1.575	-0.395	2.381	1.317

* Indicates statistically significant difference
***** Indicates no comparison calculated

Phase 2 Analysis And Results

For two of the sample groups (U.S.A. college students and U.S.A. 3rd graders) we recorded the actual responses of every participant to every item on small cards. Using the constant comparison method (Strauss & Corbin, 1990) we sorted and resorted these cards until we identified 17 groupings of responses clustered within 3 major categories. Three of the authors worked together in deriving the categories from the data.

The first of these categories was the form of the response. All of the responses were analyzed within this category, which included:

1. No Response (NR),
2. Naming (N),
3. Description (D),
4. Embellished Narrative (eN),
5. Extrapolated Exclamation (Ne),
6. Commentary (C).

The second major category focused on the way in which the participants appeared to be interpreting the graphical devices in the images. This category applied only to the responses from those participants who saw the surveys that included the graphical devices; it included subgroups defined as follows:

1. Matches the intention of the designer (M),
2. Ascribes a meaning to the device without reference to the relationship between the device and the rest of the image (MD),
3. Interprets the device with a different relationship to the image than intended by the designer (R);
4. Interprets the image in a way that would be possible if the device were not present (/D) and
5. Matches the interpretation of the device but not the intended meaning of the illustration (/M).

The third major category focused on the way that the participants seemed to be interpreting the images, and included subgroups defined as follows:

1. Matches the intention of the designer without the device present (M),
2. Names or describes the noun (NN),
3. Interprets a characteristic of the image with a different result than intended (CC) and
4. Based on a cue or interpretation unclear to us(/C).

The three main categories and subgroups with sample responses are shown in Table 5.

U.S.A. college students in our sample who saw the images without devices gave a descriptive response (a response that describes the pictorial content of the image without offering a meaning consistent with the extended meaning intended by the designer) four times as often as those who saw the images with the devices. This sample group gave embellished responses (responses containing more information than was depicted in the image) twice as often when they saw the images with graphical devices as when they saw images without the devices. The U.S.A. 3rd graders, in contrast, gave descriptive responses 18% of the time when they saw the graphical devices and 19% of the time when they did not. They gave embellished responses 69% of the time when they saw the devices and 59% of the time when they did not. Table 6 summarizes these frequencies.

Table 5
Coding Categories and Example Responses

Code	Definition of the code	Example
Form of the Response (all images)		
NR	No response	—-
N	Naming	Lizard
D	Description	The lizard laid there
eN	Embellished narrative	The lizard got hit by a car, and died
Ne	Narrative element	I am a lizard
C	Commentary	I have a pet lizard.
Interpreting the device (images with graphical devices)		
Code	**Definition of the code**	**Example**
M	Matches the intention of the designer with the device present	The wind is blowing the flower back and forth
MD	Ascribes a meaning to the device without reference to the relationship between the device and the rest of the image	The wind is blowing.
R	Interprets the device with a different relationship to the image than intended by the designer	The flower is being pushed by wind
/D	Interprets the image in a way that would be possible if the device were not present	The flower is wilting
/M	Matches the intention of the device but not the intended meaning of the illustration	The flower is leaning the wrong way.
Interpreting the image (images without graphical devices)		
Code	**Definition of the code**	**Example**
M	Matches the intention of the designer without the device present	A rabbit is jumping.
NN	Names or describes the noun	A rabbit
CC	Interpreting a characteristic of the image with a different result than intended.	The rabbit is falling.
/C	Unclear cue or interpretation	There he goes.

Table 6
Number of Responses Coded as Describing (D) or Embellished Narrative (En) for Third Graders and U.S. College Students

Form Of Response	Survey Type	Third Graders		U.S. College Students	
		Count	%	Count	%
Describing (D)	WITH Graphical Devices	111/608	.18	57/544	.10
	WITHOUT Graphical Devices	77/400	.19	281/624	.45
Embellished Narrative (En)	WITH Graphical Devices	421/608	.69	440/544	.80
	WITHOUT Graphical Devices	239/400	.59	255/624	.40

Discussion

Do graphical devices affect people's interpretations of simple pictorial illustrations?

Frequency analysis of responses indicates that graphical devices do make a difference in the way that respondents interpret the illustrations. Not surprisingly, it is evident that the participants who saw surveys with the graphical devices interpreted the images more consistently with the intention of the designers than did those who saw surveys without the devices. The difference is most striking for a conventional symbolic device (e.g., no running – image 10) than for more ad hoc devices (e.g., baseball – image 7). However, the differences are strongly evident for most of the images. The exceptions are those images that display redundant cues to the intended meaning. For example, an image of two people with speech balloons over their heads shows the people looking toward each other, one of them with her mouth open as if speaking. For the survey without the devices (in this case, the speech balloons), more participants than we might expect interpret this image consistently with our intended meaning, given the low frequency of "match" answers for other images. We speculate that the position of the figures and the open mouth of one figure were strong cues to the intended meaning of this image in their own right.

In future studies it may be advisable to reduce redundant cues where possible, although care would have to be taken that the resulting images did not violate reasonable expectations for pictorial illustrations; for instance, a person talking would ordinarily be depicted with the mouth open and to create an image contrary to this convention might interfere with the very interpretation process we hope to study.

To what extent are participants' interpretations consistent with the intentions of the designer?

The frequency analysis also shows, more interestingly, that people in all populations studied do not interpret these simple images in accord with the designers' intended meaning nearly as often as designers might hope. The International Standards Organization (ISO) standard for correct interpretations of public information symbols is 85% correct interpretations (Olgay, 2001). While instructional illustrations, usually seen in context and with accompanying text, may not need to reach this standard in order to be useful, it is important to note that no images were interpreted correctly at 85% or above across all sample groups (although no running - image 10 and talking - image 8) come close, each with only one sample group missing the 85% mark). 10th graders interpreted 6 of 16 pictures consistently with the designers' intentions at 85% or above; teachers of the deaf interpreted 7 out of 16 pictures this way. In all other populations fewer than one third of the pictures were interpreted correctly at 85% or above. Even when the threshold for interpretation is adjusted informally to account for the additional support that may be present in an instructional situations, designers may be disappointed to know that some sample groups averaged as little as 47% interpretations consistent with their intentions across the 16 items, and that the highest average for a sample group was only 70%.

In the comparative analysis the greatest number of significant differences was found between the U.S.A. college students and the Malay college students. Few differences were found between U.S.A. college students and U.S.A. teachers of the deaf and hard of hearing, and few differences were found between U.S.A. 3rd grade and U.S.A. 10th grade students. U.S.A. college students are more similar in their performance to U.S.A. 3rd graders than to Malay college students. The data to date suggest that culture and language differences can make more difference in interpreting images than developmental factors do. In light of this possibility, it is important to note that the designer of these images is from the U.S.A.

How are participants interpreting the images?

One of the more striking aspects of the individual responses from U.S.A. college student and U.S.A. 3rd grade participants (the two samples from which we categorized all individual responses according to their form) is the degree to which people include information that does not appear anywhere in the simple images themselves. A remarkable example is the response given to “dead or injured” (image 16) by a U.S.A. college student; “Lizard was run over by an elderly woman.” Fully 1355 out of the 2176 individual responses (62%) analyzed took this embellished form (eN).

We might expect this for images with graphical devices since the devices are there to extend the meaning of the images. But these responses also show up among participants who did not see the graphical devices. Sless (1981), from a semiotic-based perspective on readers interpreting texts, suggests that readers have by default a relationship to an inferred author of a text. Schriver (1997) elaborates on this relationship by suggesting that readers make active assumptions about the authors of texts and use those assumptions actively to help interpret the texts. She also suggests that readers use their experiences with similar texts for this same purpose. In response to our request that they write down a meaning for each image, participants may be supplying background context for the images from some source, concrete experiences or what they hypothesize about the author of the text, to help themselves arrive at a meaning for the image. We might have seen different types of responses if we had asked the participants to provide a label for each image instead of a meaning.

Analysis of the individual responses themselves shows that participants do appear to notice and use the devices in making their interpretations, rather than ignoring the devices or not noticing them. Responses falling into the D, R, and /M subgroups (62/542 or 11%) are those in which the interpretations made by participant do not match the meanings intended by the designer, even though participants do appear to be using the graphical devices in those interpretations. The implication here is that designers cannot assume people will ignore graphical devices if they do not understand them, or that people will interpret those devices as the designer expects them to.

The devices make a qualitative difference in the form of the responses. Participants who did not see the devices were four times more likely to give descriptive responses (subgroup D – describes the pictorial content of the image only) than were participants who did see the devices. Since the devices are used to extend the meaning of an image beyond its pictorial content, it appears that the devices are fulfilling their general purpose even when their specific meanings are not automatically clear.

Limitations Of The Study

The images that we used are simple and they were viewed outside the learning context, which may have influenced the participants' responses by depriving them of additional cues to the designers' intended meanings which might have been present in an authentic learning situation. In this study design the investigators did not have access to the respondents' reasoning process for giving the answers they gave, so the analysis of their individual answers was limited to grouping their responses based on characteristics of those responses. The images we used for this iteration of the study are not categorized by type, so within-subject analysis was not possible at this time.

Future Research

Plans for extensions of this research include studying instructional illustrations in the context of authentic learning activities and under conditions that expose the participants' interpretation process to observation.

The authors are also building a collection of instructional illustrations that contain graphical devices from around the world. Using a grounded theory approach, we expect to develop a taxonomy of graphical devices. This taxonomy will be used to develop a true instrument for investigating within-subject performance in interpreting images with graphical devices, and for investigating which types of devices may be most difficult to interpret.

Acknowledgements

The authors acknowledge gratefully the contributions of our colleague who participated in data gathering and translation, Professor Fong Soon Fook.

References

Anglin, G. J., Towers, R. L., & Levie, W. H. (1996). Visual message design and learning: The role of static and dynamic illustrations. In D. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 755-794). New York: Macmillan Library Reference USA.

Boling, E., Frick, T., Sheu, F. & Huang, J. (2002, November). *Perceived meanings relative to intended meanings of common graphical elements in instructional illustrations.* Paper presented at the meeting of the Association for Educational Communication and Technology, Dallas, Texas.

Braden, R. A. (1996). Visual literacy. In D. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 491-519). New York: Macmillan Library Reference USA.

Cooper, L. Z. (2002). Consideration in cross-cultural use of visual information with children for whom English is a second language. *Journal of Visual Literacy, 22*(2), pp. 129-142.

Drucker, J. & McGann, J. (2000/2001). Images as the text: Pictographs and pictographic rhetoric. *Information Design Journal, 10*(2), 95-106.

Eisner, W. (1985). *Comics and sequential art.* Tamarac, FL: Poorhouse Press.

Evans, M.A., Watson, C. & Willows, D.M. (1987). A naturalistic inquiry into illustrations in instructional textbooks. In H.A. Houghton and D.M. Willows (Eds.). *The psychology of illustrations: Vol 2: Instructional issues.* New York, NY: Springer-Verlag.

Evamy, M. (2003). *World without words*. London, UK: Lawrence King Publishing, Ltd.

Goldsmith, E. (1984). *Research into illustration: An approach and a review.* New York: NY: Cambridge University Press.

Hagen, M. A.(1980). Generative theory: A perceptual theory of pictorial representation. In M.A. Hagen (Ed.). *The perception of pictures, Vol. 2,* pp. 3-46. New York, NY: Academic.

Harrison, C. (2003). Visual social semiotics: Understanding how still images make meaning. *Technical Communication, 50*(1), 46-60.

Kennedy, J.M. (1994). Picture perception. In Sebeok, T. and Umiker-Sebeok, J. (Eds.) *Advances in visual semiotics: The Semiotic Web.* Berlin and New York: Mouton de Gruyter, pp. 185-215.

Levie, W. H. (1987). Research on pictures: A guide to the literature. In D.M. Willows and H.A. Houghton (Eds.). *The psychology of illustration, Vol. 1: Basic research* (pp. 1-50). New York, NY: Springer-Verlag.

Levin, J., Anglin, G. & Carney, R. (1987). On empirically validating functions of pictures in prose. In D.M. Willows and H.A. Houghton (Eds.). *The psychology of illustration, Vol. 1: Basic research* (pp. 51-85). New York, NY: Springer-Verlag.

McCloud, S. (1994). *Understanding comics: The invisible art.* New York, NY: Harper Collins Publishers.

Olgay, N. (2000 - 2001). Development and testing of the IIID safety symbols system. *Information Design Journal*, *10*(2), 107-114.

Peeck, J. (1987). The role of illustrations in processing and remembering illustrated text. In D.M. Willows, and H.A. Houghton (Eds.). *The psychology of illustration: Vol 1: Basic research.* New York: NY: Springer-Verlag.

Pettersson, R. (2002). *Information design: An introduction.* Amsterdam, John Benjamins.

Rollins, M. (1999). Pictorial representation: When cognitive science meets aesthetics. *Philosophical Psychology, 12*(4), pp. 387-413.

Samuels, S.J. (1970). Effects of pictures on learning to read, comprehension and attitudes. *Review of Educational Research, 40*(3), 397-407.

Schapiro, M. (1969). “On some problems in the semiotics of visual art: Field and vehicle in image-signs.” *Semiotoca, 1*, 223-242.

Schriver, K. (1997). *Dynamics in document design: Creating texts for readers.* New York, NY: John Wiley & Sons.

Sless, D. (1981). *Learning and visual communication.* New York: Halstead Press.

Strauss, A. & Corbin, J. (1990). *Basics of qualitative research: Grounded theory process and techniques*. Newbury Park, CA: Sage Publications.

Young, S. L. & Wogalter, M. S. (2000/2001). Predictors of pictorial symbol comprehension. *Information Design Journal, 10*(2), 124-132.