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Abstract

This paper tells the story of an arts-informed, visual study–the iSquare Research Program–and the four visual analysis techniques that have been used across its history: compositional interpretation, thematic analysis, pictorial metaphor analysis, and content analysis. When each analytical strategy was applied, in turn, to the visual data set of more than 2,000 original drawings, different insights about the target subject of 'information' came into view. To begin, the iSquare Research Program is introduced and placed in the disciplinary context of information science. One at a time, the research questions that emerged in the project and their complementary analytical strategies are outlined, with attention to matters of implementation, interpretation, and results. By the conclusion, readers will be able to distinguish and compare the four visual analysis techniques and can thereafter synchronize one or more to their own research projects and questions. Overall, what follows is an adventure story about the selective focusing power of analytic lenses and their ability to generate myriad discoveries within a singular visual data set.

Keywords: Arts-informed methods; visual research; draw-and-write technique; visual analysis; information; iSquare

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The iSquare Research Program

For 100 years, scholars, practitioners, and students of information science have struggled to understand and define the field's central concept of 'information', and dozens of definitions for information have been put forward. Some definitions are highly technical, such as: K[S] + Δ I = K[S+ ΔS], a formula which can be translated to mean that information is anything that changes the structure of knowledge in the mind (Brookes, 1980). Other popular conceptions are that information is, 'the pattern and organization of matter and energy (Parker, 1974) or an element in the sequence: data>information>knowledge>wisdom (Rowley, 2007). A movement towards more social approaches in information science has generated the idea that information is a by product of conversations (Talja, 1997). Amidst the cacophony, one scholar has argued that information science would be better off without a definition of information (Furner, 2004). The debate around definitions of information has generated theoretical uncertainty; a rift between scholarship and practice; and challenges in converting and inspiring students. For sure, the problem of fundamental definitions is not unique to information science. All disciplines have their beloved and contested central concepts, whether 'culture' in anthropology', 'social' in sociology, or 'gender' in women's studies.

As a response, in 2011 I launched the first study of information in information science in an alternative arts-informed (Cole & Knowles, 2008), visual mode (Prosser & Loxley, 2008). The iSquare Research Program (www.iSquares.info) explores how people visualize the concept of information; how visual conceptions of information differ among various populations; and how these images relate to conceptions of information made of words. The research design was centered on a novel formulation of the draw-and-write technique (Backett-Millburn & McKie, 1999; Pridmore & Bendalow, 1995). In a classroom setting, research subjects are given a 4.25-by-4.25-inch square of white art paper and a black pen, and are then asked to respond to the question, 'What is information?' in the form of a drawing. The activity is shown in Figure 1. On the reverse side of the same piece of paper, the participants are prompted to, 'Say a few words about your drawing.' The exercise occurs during 10 minutes of class time and produces a compact piece of visual and textual data coined an 'information square', or 'iSquare' for short. [See Hartel (2014a) for a review of the draw-and-write technique and additional details about the iSquare data gathering protocol.]

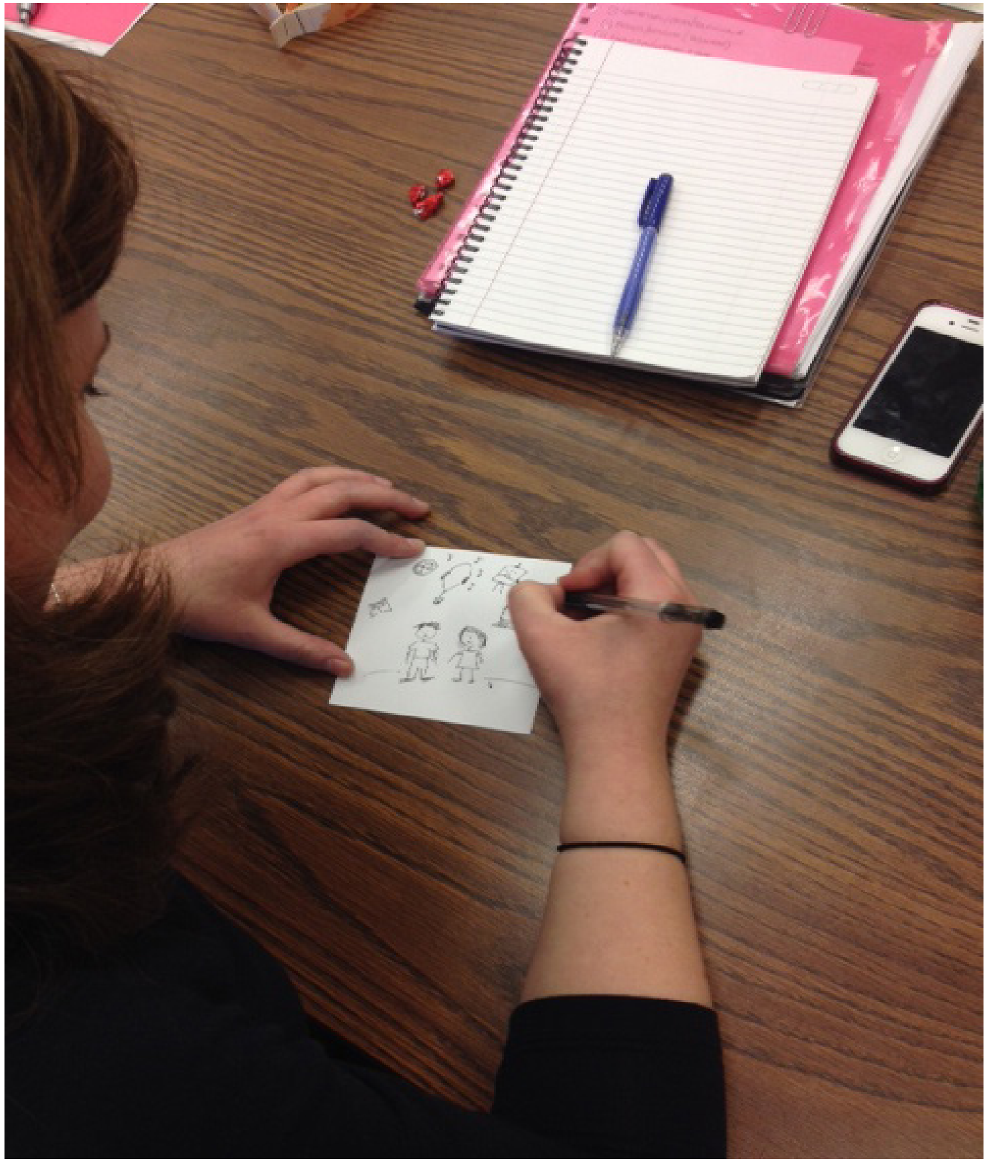


Figure 1. In the iSquare data gathering protocol, a participant draws a response to the question, 'What is information?' on the front side of the paper, and responds to the prompt, 'Please say a few words about your drawing' on the reverse side.

Since inception, more than 2,000 iSquares (and counting) have been gathered from difference academic disciplines and countries around the world. Though criticized by more conservative scholars of information science who prefer a traditional, text-based, philosophical-analytic research paradigm, the project won a research innovation award from the American Society for Information Science and Technology. The findings have been reported in the literature (Hartel, 2014a, 2014b; Hartel & Savolainen, 2016) and been mounted at conferences as art exhibitions (Hartel, 2013a, 2013b). The iSquare Research Program now stands as an alternative visual conception of information and has initiated interest in arts-informed research designs across information science. The study delivers what Weber states as the benefits of visual research, that is, 'Images can be used to capture the ineffable, the hard-to-put into words … and images can be more accessible than most forms of academic discourse' (2008, p. 34). Parallel to the research, pedagogical benefits have been realized and hundreds of students in my courses have been introduced to the elusive concept of information through drawing (Hartel, 2014c).

Visual Analysis of Draw-and-Write Data

Though draw-and-write data is relatively easy to collect, the resulting visual data sets are harder to analyze. Numerous visual analysis techniques are outlined in handbooks (Rose, 2007, van Leeuwen & Jewett, 2001), but the majority are geared to mass communications rather than participant-generated drawings. Unfortunately, most precedent draw-and-write studies provide only fleeting accounts of analysis, adding to the ambiguity that surrounds the analytical process (Mair & Kierans, 2007).

One especially helpful general rubric for visual analysis appears in the handbook Visual Methodologies: An Introduction to Researching with Visual Materials, 2nd ed. (Rose, 2007). According to this source, all images have three potential sites of analysis. First, there is the site of production; in the case of the iSquares, that is the drawing activity in the classroom setting. Second, there is the site of the image itself, which entails the drawing as a visual artifact. Third, there is the site of the audience; which includes the display of the drawings in articles or exhibitions in conjunction with the viewers' responses. While all three sites are interesting and the three are interconnected, the four accounts of analysis that follow are exclusively focused on the second site: the iSquare image itself.

Next, we return to the story of the iSquare research program. Over five years, a variety of research questions emerged organically and lead to four adventures in visual analysis.

Compositional Interpretation

In 2011 the first 137 drawings of information were collected from a convenience sample of masters students at the Faculty of Information, University of Toronto. The research team was surprised and delighted by the range of visual expressions. In some cases, information was rendered as if by a child's hand, while many others were masterful artworks. The images were literal, abstract, symbolic, and metaphorical. The visual influences included the arts (e.g. portraits, landscapes); the sciences (e.g. schematic diagrams, tables); and popular culture (e.g. cartoons, consumer brands). Given the unexpected diversity in the forms of the drawings, our initial attempt at visual analysis was motivated by the question: How do graduate students of information science draw 'information'?

To answer this question, we employed compositional interpretation (Rose, 2007, Ch. 3), that is, 'a way of looking very carefully at the content and form of images' (p. 39). In compositional interpretation, analytical attention is placed on the formal qualities of images instead of their social construction or cultural impact. Compositional interpretation is the traditional analytical strategy of art history and art criticism and has most often been applied to paintings. In practice, an expert relies upon visual connoisseurship to judge the images in terms of the conventions of their genre.

To illustrate, compositional interpretation could be applied to the exhibit Italian Futurism, 1909–1944: Reconstructing the Universe, at the Solomon R. Guggenheim Museum in New York, in 2014. Futurism was an artistic and social movement that originated in Italy in the early twentieth century. It glorified themes associated with the future, including speed, technology, youth, and violence. As a genre of painting, Futurist works had a signature subject matter and use of abstraction, distortion, motion, pointillism, and color. An art historian or art critic, being versed in the ideals of Futurism, would apply compositional interpretation to the Guggenheim exhibit by evaluating how each artifact in the show manifests the characteristics of the genre.

To apply compositional interpretation to our data set, we had to determine: What genre are the iSquares? What are the conventions of that genre? Subsequently it was necessary to become connoisseurs and experts of that genre. The iSquares, generally speaking, are drawings. More specifically, we deemed them to be 'graphic representations' per The Language of Graphics: A Framework for the Analysis of Syntax and Meaning in Maps, Charts and Diagrams by visual scholar Yuri Engelhardt (2002).

According to Engelhardt, there are ten primary types of graphic representation: picture, statistical chart, time chart, link diagram, grouping diagram, table, symbol, composite symbol, and written text. Each major type has common traits and a particular graphic syntax. For example, a picture is a graphic representation that serves to represent the physical structure of physical objects, and is often a person, place, or thing. A link diagram involves the relation of linking together graphic sub-objects (Engelhardt, 2002, p. 140); typically, a link diagram features one or more nodes joined by a connector that is an arrow or line. The research team became experts in graphic representations and performed compositional interpretation on the iSquares by invoking Engelhardt's classification system and its descriptive concepts and vocabulary.

The process had two stages. First, each iSquare was individually contemplated and identified as one of the ten primary types. Second, the drawings were viewed in sets based upon their major type. For example, we pondered all the iSquares that were symbols, recorded their general principles, and documented associations to existing conceptions of information from the literature of information science documented associations to existing conceptions of information from the literature of information science.

The first 143 iSquares exemplified several different types of graphic representations in Engelhardt's schema. Half of the images were pictures (72); there were a significant number of link diagrams (33); and there were notable occurrences of grouping diagrams (10), symbols (9), and written text (8). There were very few tables (2), and no instances of composite symbols, statistical charts, time charts, or maps. Three iSquares were left blank by students and were classified outside of Engelhardt's schema as 'other'. The six most common types of graphic representation are illustrated and characterized in Table 1.

The findings went on to display and discuss how information manifested in each of the major types of graphic representation, and any associations to written conceptions of information in the information science literature. For example, among the 'pictures', there was a recurring style that resembled wallpaper (as shown in Figure 3):

About the iSquares that resemble wallpaper we reported: 'Such iSquares contain a repeated motif or pattern that fill the graphic space entirely and with an electric dynamism. Being quite intricate, one suspects the idea struck students right away and then every available minute was used to bring the vision to fruition. [...] The highly abstract wallpapers bring to mind the earliest conceptions of information by Wiener and Shannon, involving signals, noise, redundancy, and feedback loops. The wallpaper iSquares also resonate with structural definitions of information such as "the pattern and organization of matter and energy" (Bates, 2006, p. 1033).' (Hartel, 2014a).

Most iSquares fit into Engelhardt's typology without issue. However, sometimes an iSquare did not conform easily to the schema because it exhibited features of more than one of the ten main types. While this classification system acknowledges that there are hybrids, the iSquares sometimes displayed varieties of hybridization not well addressed in Engelhardt. In questionable cases, the determination was discussed by the research team until a single type was agreed to be the stronger presence.

It was highly beneficial for our research team to learn and use a rich, authoritative, and descriptive vocabulary geared to the genre at hand: graphic representations. Early in the iSquare study, an initial remark may have been, 'That one is really busy and has lots of arrows connecting things.' As Engelhardt's thesis and its terminology were digested, observations became more precise: 'That one is a highly schematic, composite graphic object and a link diagram featuring four nodes and bidirectional arrows...' With such fluency, the project team was poised for more meaningful discoveries.

This particular analytical project also created a stable and extendible system to compare iSquare data sets. For example, the first 137 iSquares gathered from students within an information studies program in North America resulted in the majority of the data set being pictures. A later study using the same iSquare protocol upon a population of archivists in Western Australia generated a superabundance of grouping diagrams (Joseph & Hartel, 2015). This motivates the question of what accounts for such differing visual conceptions of information across specialties and geographies of information science.

Thematic Analysis

In the second year of the project, more iSquares were collected from graduate students at the Faculty of Information and the data set grew to 293. During the analytical process for compositional interpretation, we noticed many drawings of human beings, a visual motif that reflects how information science is increasingly oriented to social phenomena. Human figures also channel a central research area in the field known as information behaviour, which concerns, 'the many ways in which human beings interact with information, in particular, the ways in which people seek and utilize information' (Bates, 2010, p. 2381). Against this backdrop, we became curious to better understand how and why people appear in the iSquare drawings, and asked: What can iSquare drawings of information suggest about information behaviour?

The first step towards answering this question was to create a distinct sub-set of the corpus that could be unambiguously associated with information behaviour. It seems almost too obvious to state that people are a qualifying and central marker of information behaviour scholarship and should characterize its visual vocabulary. Therefore, we isolated the iSquares that contained a human being or human body part. Of the 293 iSquares, 126 (43%) qualified and were recast as 'information behaviour squares,' or 'ibSquares,' deserving further consideration.

Next, thematic analysis (Braun and Clarke, 2006) was performed upon the 126 ibSquares. Thematic analysis is a flexible qualitative method for identifying, analyzing and reporting patterns, called themes, within data. In thematic analysis epistemological assumptions must be made explicit at the outset, as follows: We applied a deductive form of 'theoretical' thematic analysis that viewed the ibSquares in light of major theories, concepts and trends of information behaviour research. The theoretical approach stands in contrast to inductive thematic analysis that aims to solicit indigenous themes from the data. Further, the drawings were

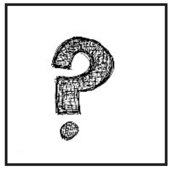
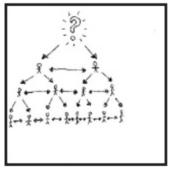
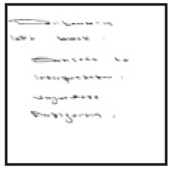
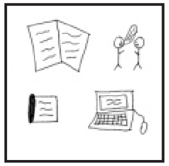
 picture	A picture is a graphic representation that serves to represent the physical structure of physical objects. Put another way, an iSquare that is a picture involves a literal correspondence to its referent in the world, which is usually a physical object or scene.	 symbol	A symbol is an element of communication intended to represent or stand for a person, object, group, process, or idea [22].
 link diagram	A link diagram involves the relation of linking together graphic sub-objects. A link diagram features one or more nodes joined by a connector, usually an arrow or line.	 written text	According to Engelhardt, written text is a special case of graphic representation involving human language that is lined up in the graphic space and ordered though grammar.
 grouping diagram	A grouping diagram expresses the categorization of a set of elements. Sometimes labels are used to identify graphic sub-objects, underscoring the intent of enumeration.	 table	A table features a simultaneous combination of horizontal separations and vertical separations and/or a simultaneous combination of horizontal lineups and vertical lineups.

Table 1. Examples of iSquares that qualify as major forms of graphic representation, per Engelhardt (2002).

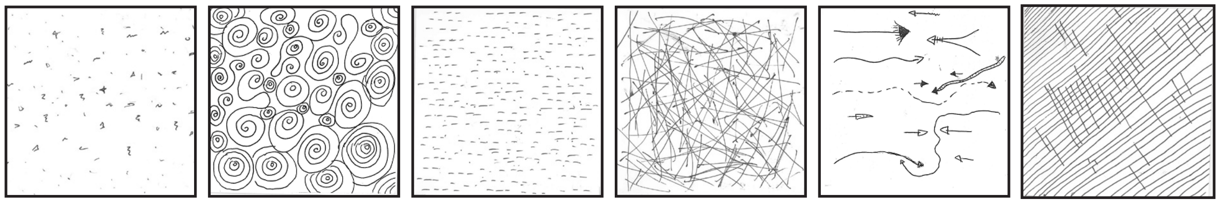


Figure 2. Examples of pictures that resemble wallpaper.

seen in a realist or essentialist manner that embraced their surface reality, rather than their socially-constructed, latent or metaphorical meanings. From this deductive and realist epistemological stance, the analysis process entailed: 1.) Familiarizing oneself with the data, 2.) Generating initial codes, 3.) Searching for themes, 4.) Reviewing themes, 5.) Defining and naming themes, and 6.) Producing the report.

Throughout the analysis process it was discovered that despite their common humanity, the 126 ibSquares were actually quite diverse. The drawings ranged from simple smiley faces or stick figures to artful and expressive portraits. People appeared solo, in dyads, or as groups. The actors were on the sidelines or stood front and center. The figure(s) occupied a stark canvas or inhabited a cluttered information environment.

Upon applying thematic analysis, themes were identified as: the hands, the brain, a person thinking, an individual in a context, a twosome in information exchange, and an information-rich social world (Hartel, 2014b) (as shown in Figure 4).

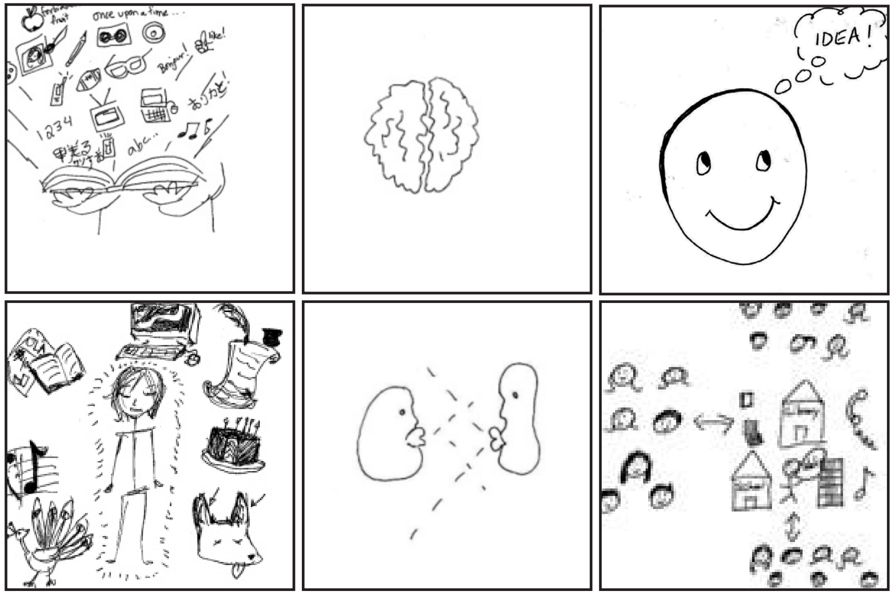


Figure 3. Example ibSquares that reflect the themes of (left to right): the hands, the brain, a person thinking, an individual in a context, a twosome in information exchange, and an information-rich social world.

The paper 'Information Behaviour Illustrated' explicates each theme in the context of information behaviour theory.For example, concerning the theme of a person thinking (as shown in Figure 4):

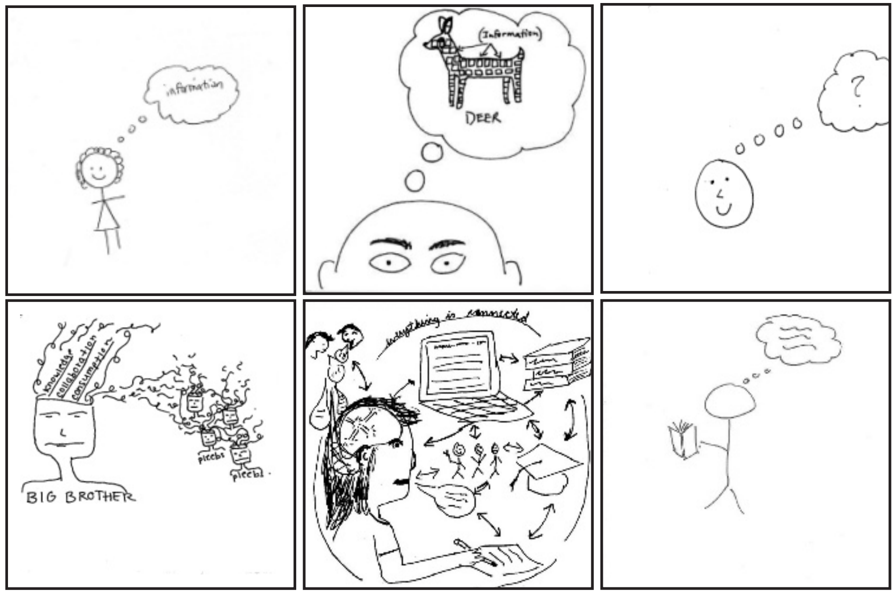


Figure 4. Example ibSquares that express the theme a person thinking.

> These ibSquares of a person thinking reflect the cognitive viewpoint in information science and information behaviour. Anchored in Brookes' (1980) fundamental equation (K[S] + Δ I = K[S+ ΔS]), in which information produces a change in a knowledge structure, the cognitive perspective centers information phenomena in the mind. [...] the actor appears alone on the page, devoid of sociality and context. Nothing exists in the surroundings to influence what is happening inside the head. This chronic individualism and mentalism is the crux of the critique of the cognitive perspective that emerged in the 1990s and that continues today. (Hartel, 2014b)

The process of identifying visual themes related to information behaviour was productive. The themes and their associated drawings had potential to complement the scholarly literature of information behaviour, simplify some of its abstract concepts, accommodate diverse learning styles and intelligences, and seed lively classroom discussions. In short, the thematic analysis delivered what Weber (2008, p. 34) claims as the benefits of visual research, that is, 'Images can be used to capture the ineffable, the hard-to-put into words…and images can be more accessible than most forms of academic discourse.'

Pictorial Metaphor Analysis

Since inception, the research team had noticed drawings of information that took the form of metaphors—as when information was cast as a tree or light bulb. A literature review confirmed that visual metaphors for information had never been systematically examined. Hence, as the corpus grew to more than 1,000 drawings, we embraced a new set of questions: What are the main pictorial metaphors used by iSchool students when expressing information as a drawing?; What are the formal qualities of these depictions?; and what makes the resulting pictorial metaphors suitable for conceptualizing information?

For guidance we turned to Conceptual Metaphor Theory (CMT) and its associated analytical strategies. Since the 1980s, CMT has provided a predominant perspective on the study of metaphors. CMT was developed within the field of cognitive linguistics, and this theory became widely known with the publication of Metaphors We Live By, by George Lakoff and Mark Johnson (1980).

From the perspective of CMT, metaphors link two conceptual domains, the source domain and the target domain. By means of an expression taken from a concrete area (the source domain), something located in the target domain may be made more understandable. The target domain is abstract, unknown, and difficult to envisage, as far as its meaning is concerned. (In the context of the iSquare study, it follows that some students invoked concrete, tangible source domains such as trees or light bulbs to express the more abstract target domain of information.)

The vast majority of studies inspired by CMT focus on verbal manifestations of metaphor. However, there is no exclusive verbal link between a source and target domain (El Refaie 2003, p. 76). Forceville argued for a broader view by introducing the concept of multimodal metaphor (2009), a construct in which source and target features are represented by at least two different modes of perception. It follows that some multimodal metaphors can be described as pictorial metaphors in which the source and target domains are images (Forceville, 2008). Hence, we undertook a CMT-inspired pictorial metaphor analysis of a sample of iSquares.

As a first step, a sample of 417 iSquares from information science schools in Canada and Europe were extracted from the larger corpus. Since not all of these drawings qualified as pictorial metaphors, an elimination process was necessary. The two lead researchers independently checked all the 417 iSquares for the potential presence of a pictorial metaphor, as manifest in a recognizable and unambiguous source domain. The process was informed by the compositional interpretation conducted two years earlier (e. g. some forms of graphic representation, per Englehardt, were unlikely to be pictorial metaphors), proving that a sequence of analytical techniques can advantageously complement each other. After eliminating non-pictorial metaphors, the original data set of 417 was reduced by 292 to 125.

The remaining 125 iSquares were analyzed inductively by the researchers to identify recurring pictorial metaphors (which was essentially a thematic analysis), and seven were chosen for further elaboration based upon their prevalence and diversity. The pictorial metaphors were` information as: the Earth, web, tree, light bulb, box, cloud, and fishing/mining (as shown in Figuree 5).

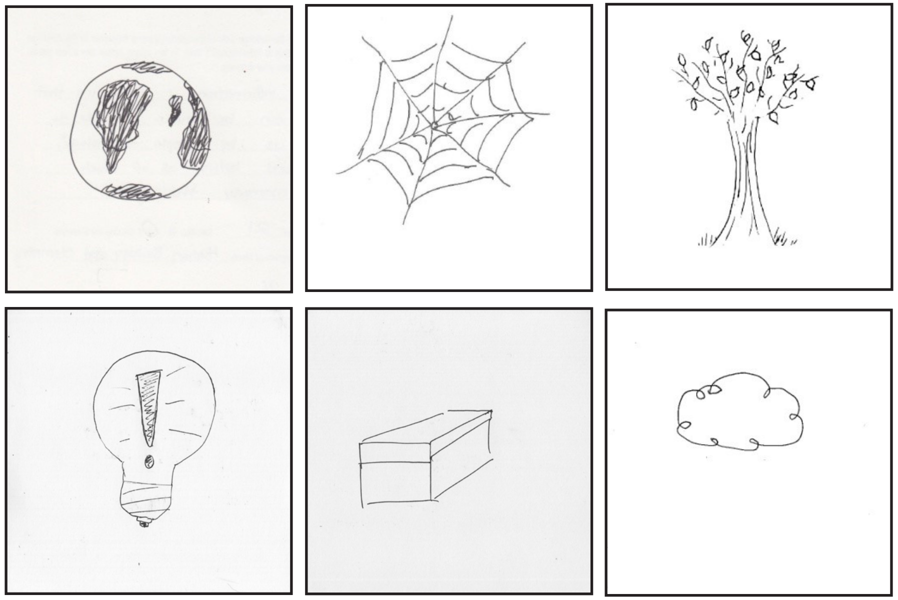


Figure 5. Example iSquares that reflect pictorial moments: information as: the Earth, cloud, web, tree, light bulb, box, and fishing/mining.

Next, each of these pictorial metaphors was examined carefully for its formal qualities by asking 'What is it? What is happening? How is it drawn?' In the spirit of CMT, we then sought to articulate the relationship between the source domain and the target domain of information. To that end, attention was sharpened by the questions, 'What does the drawing suggest about information?' or 'How is information like this?' Our knowledge of the source domains was based upon our innate cultural and visual literacies, as well as general encyclopaedias and visual dictionaries (e.g., Becker, 2000; O'Connell and Airey, 2011; Tressider, 2004). An understanding of the target domain of information was shaped by writings about information in the scholarly literature.

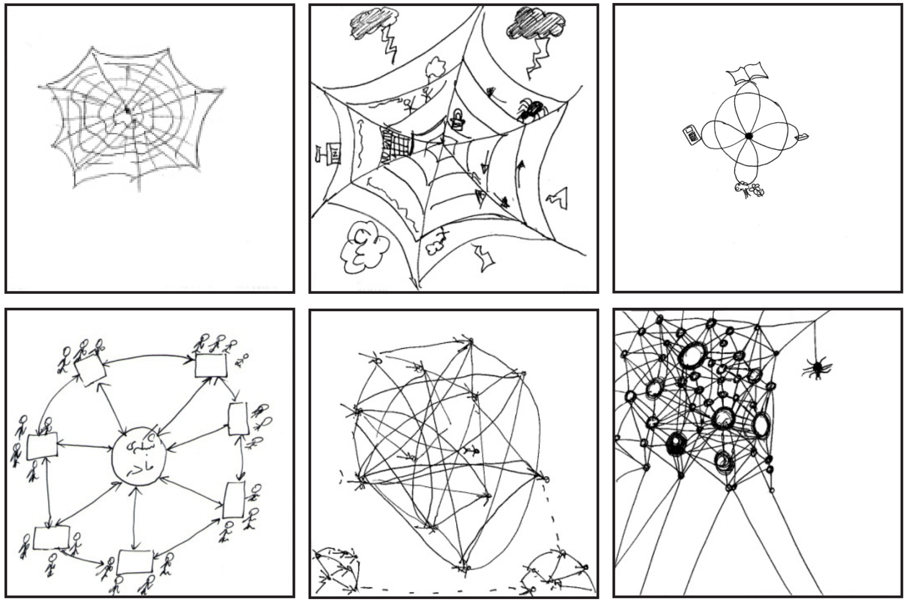


Figure 6. Example iSquares that show the pictorial metaphor of information-as-web.

For example, concerning the pictorial metaphor of information-as-web (as shown in Figure 6), we reported:

> …These drawings take the recognizable shape of the orb weaving spider, with an epicenter, radials, and capture spiral; or they are the more tangled and asymmetrical cobweb built by other spider species. The pictorial metaphor of information as a web brings attention to the structure of information. Here, information is cast with a Cartesian sensibility upon a plane made of intersecting points, lines, and cells. This pictorial metaphor posits information as distributed, parceled, and spacious rather than centralized, monolithic, and dense. The silk that forms a web is invisible and quite strong, qualities shared by information, too.
> (Hartel & Savolainen, in press)

Concerning the limitations of the pictorial metaphor analysis, it must be noted that less than 30% of the data set qualified as pictorial metaphors, making them a minority strategy for representing information as an image. Further, the process to identify and interpret pictorial metaphors was highly subjective. But once thoroughly characterized, the pictorial metaphors for information provide a creative complement to written conceptions of information and bring a greater sense of history, humanity, nature, and beauty to the understanding of information today.

Content Analysis

Over the years, the iSquare research program captured the imagination of scholars in information science worldwide. Many of these observers wanted to examine drawings of information from their own students to see how they compared to the North American sample reported in Hartel (2014a). A project was organized under the umbrella of an ‘International iSquare Study,’ with contributors[1] in Australia, Brazil, Canada, Croatia, England, Finland, France, Ghana, Iran, Malaysia, Russia, and Taiwan. The collaborators were trained in the iSquare protocol and mailed a kit of blank iSquares, black pens, and an instructional script. 541 new iSquares were gathered from graduate students of information science in the 12 countries, a mean of 45 drawings per site. The broad question guiding the enterprise was: How is the concept of information visualized in my community and beyond?

To document how the concept of information was visualized in the drawings from each country individually and across the corpus as a whole, we selected content analysis, an analytical strategy that enabled visual motifs within the data set to be rigorously qualified and quantified. Specifically, the research team performed a descriptive content analysis (Neuendorf, 2002, 53-54), which has as its goal a numerically-based summary of a chosen data set.

The global team was strongly committed to an egalitarian and culturally-sensitive work process since the definitions of information that dominate the literature are Euro-centric. To this end, a shared, virtual project environment was maintained via technology. Once collected, the international iSquares were mounted to a web-based, password protected repository that could be accessed by participants from anywhere.

In keeping with standard practices of content analysis, the first step in the process was to create a coding framework. To capture a universal perspective on information it was produced and refined incrementally through email communications among the extended team. The coding framework was composed of form and content variables and their values. Form variables pertained to formal features of each iSquare. For example, the form variable of complexity was measured in the values of low, medium, or high, corresponding to the extent to which the iSquare canvas was busy, or put differently—filled with ink.

Content variables and their values expressed features or dimensions of information relevant to information science scholarship. For example, the content variable of print artifact was measured in the values of artwork, book, book collection, scroll, generic document, newspaper/magazine, map, or sign. (Essentially, this variable and its values establish a system to thoroughly audit the iSquares for the appearance of print artifacts.) Other content variables deemed by the contributors to be of interest within information science were: information behaviour, information and communications technologies, information structures and organization, and the settings for information—each was elaborated with a series of values.

The actual analysis process consisted of many hours of coding: team members identified and recorded the variables and values present (or not) within each iSquare. To enable the 12 researchers on different continents to code the drawings easily and consistently, we translated the coding framework into an easy-to-use online survey (hosted by Google Forms), in which the survey questions expressed the variables and the multiple choice answers were the values. In practice, coders would focus on a single iSquare and answer all the survey questions, in turn, as they relate to each iSquare. The Google Form automatically tabulated the responses in an Excel spreadsheet that was managed by the team's data analyst.

In content analysis, it is important to maintain high intercoder-reliability, which is easier to achieve with a small group of coders in a single location. Hence, it was decided that the Toronto-based organizing team would code the entire corpus, to establish a baseline. At the same time, each contributor would code the drawings from their own country. The dual-coding process produced a double set of results with two specific benefits. First, each contributor fully interpreted the data set from their country and was poised to write-up findings; second, the doubly-coded data provided an opportunity to examine and report to the methodological literature any interpretive differences between the coding outcomes from the Toronto-based team and those by the contributors in each country.

The final steps of the descriptive content analysis for the International iSquare Study are still in progress. The Toronto-based team will continue to characterize the visual motifs across the corpus, for publication in a scholarly journal of information science. Simultaneously, each contributor will use the results from their country as the foundation for a chapter in an edited book about the project.

Conclusion

By definition, an adventure is 'an unusual, exciting, typically hazardous, experience or activity' and suits the title of this paper. It is unusual to apply four visual analysis techniques to a single corpus of visual data. To review, compositional interpretation was a means to describe the iSquares in terms of the genre of graphic representation. A thematic analysis upon iSquares that featured human beings helped to illustrate major concepts of information behaviour. A pictorial metaphor analysis illuminated the familiar source domains that make the concept of information more tangible and comprehensible. Finally, a content analysis of iSquares gathered in 12 countries quantified the visual motifs common to the corpus and unique to individual geographies. The journey was hazardous when expert peer reviewers detected minor mistakes in our analysis process—perhaps due to the steep learning curves inherent to mastering any analytical strategy. In the future, the iSquare data gathering protocol will be used to explore other concepts in information science, such as 'data' and 'library', and so the adventures in visual analysis will continue.

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(notes)

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