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Teaching the Design of Narrative Visualization: Using Metaphor for Financial Literacy and Decision Making

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Abstract:*The authors provide a scholarly definition for metaphor-rich, story-driven "narrative visualization," and assert the importance of this methodology in contemporary design education. They propose "narrative visualization" as especially useful in promoting financial literacy: a context in which design can both facilitate understanding and possibly influence behavior. This emotionally-engaging means has the potential to affect the "System 1" intuitive decision-making processes that Kahneman and others have identified as the primary drivers of financial behavior.The case study here presents a recent design course that was customized to teach "narrative visualization" in a financial-literacy context. Student work from that course is examined through a newly-devised framework: the infoEmotion© matrix of visual and content elements. The infoEmotion© matrix is introduced here as a first step toward establishing best practices for teaching "narrative visualization" and for assessing animations, graphic novels, informational short films, and illustrations.*

Keywords: Design education, Narrative visualization, Information design, Metaphorical visualization, Behavioral finance, Financial visualization, Financial illustration Financial literacy, Financial education, Financial capability

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Introduction

In this paper we assert the importance of narrative visualization methodologies as part of a contemporary design education, and argue that narrative visualization is especially important in any context in which design can both facilitate understanding and potentially influence behavior (e.g., public health, disaster management). Recent research in behavioral economics suggests that such narratively-driven approaches to information design (in particular, their reliance on metaphor), engage the cognitive dimensions of "System 1" thinking, and thus have a strong impact on decision-making. Narrative visualizations are thus a crucial tool in the growing field of financial literacy.

The 2008 recession prompted governments and non-profit organizations in the U.S. and other countries to step up their efforts to improve financial literacy among the public (c.f. the Financial Literacy Research Consortium, http://www.ssa.gov/pressoffice/pr/flrc-pr.htm). As with public health, disaster management, and other areas of public importance, one of the key research and funding priorities has been to develop more effective communication strategies and educational resources. Existing financial literacy materials—however thoroughly planned and assessed—often lack consistent, comprehensible design methodologies. (Please note that for policy-makers the word "design" usually connotes only the design of research instruments such as surveys or studies.) This lack of methodologies presents a significant opportunity for design educators and designers in the 21st Century. In the design classroom, financial literacy provides an excellent context within which to give students an understanding of how narrative visualizations function; financial literacy also provides opportunities for students to broaden their skills in information design to include a wider range of visualization strategies.

This paper is in two parts. In Part 1 the authors present our definition of "narrative visualization": in particular, its reliance on visual metaphor. We then relate the emotional and cognitive impact of narrative visualizations to recent research in behavioral economics and to psychological studies regarding individuals' interpretation of information and making of financial decisions. In Part 2 we apply these insights to a case study in which design educators and financial educators collaborate to approach financial literacy as a "design problem" for students in a design class. We develop a conceptual framework that we call an "infoEmotion© matrix" which defines the constituent factors of a typical narrative visualization, and we use it to analyze two examples of student work. Finally, we discuss how the infoEmotion© matrix may be used to develop assessment tools for educators, and we outline directions for future work.

Part I: Narrative Visualization and Behavioral Economics

Defining "narrative visualization"

The authors define the term "narrative visualization" to refer to illustrations, animations, storyboards, and graphic novels that engage the viewer with metaphor and storytelling. This is very different from the use of the same term by researchers such as Edward Segel and Jeffrey Heer (Segel and Heer 2010) from the computer- and graphics-oriented Stanford VIS group (http://vis.stanford.edu/), who emphasize the storytelling aspects in visualizations of complex data sets and other schematics. In the financial literature, data-driven visualizations are intended to provide context, amplification, and cognitive assistance in interpreting data by highlighting, illuminating, suppressing, or

supplementing the financial information that is embedded in the data. This important data-driven work certainly has implications for the emerging field of "data journalism," but the "Stanford" use of the term "narrative visualization" is very different from the "Parsons" use here.

In contrast, the authors' ("Parsons") definition of "narrative visualization" refers to the kinds of illustrations that are frequently used to explain financial concepts and elements in financial journalism and financial education materials (see Figure 1). Largely hand-drawn and pictorial—combining simple imagery with graphic elements—these visualizations use metaphors and implied relationships to imbue complex financial concepts with emotional or conceptual context. These narrative visualizations often depict emotional cues (pain, fear, joy) overtly through a character's body language and facial expression when referencing issues that have emotional resonance for the viewer. This resonance allows viewers to engage with the concepts on an intuitive basis—one that relates to heuristic-based "System 1" thinking (Kahneman 2011). As we discuss in the section "Two systems thinking" below, the intuitive engagement that narrative visualizations engender may have a significant impact on financial decision-making and behavior.

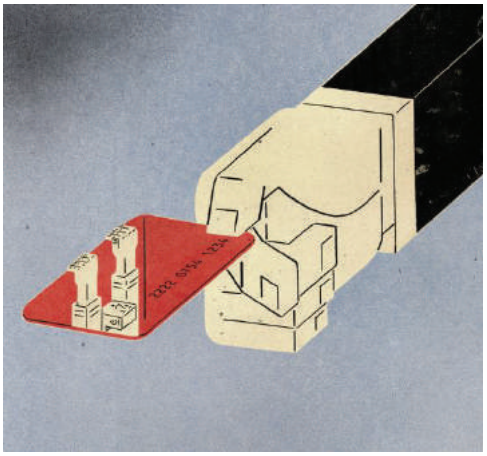

Figure 1. "Avoiding the Credit Card Trap," David Plunkett, Business Week, Feb. 13, 2006

Comparison of the two examples highlights some differences between data-based and narrative-based visualizations. The visualization in Figure 2 lies somewhere along a continuum ranging from "pure" information/data-driven to "pure" pictorial/narrative, and integrates elements of both. Figure 2 illustrates the ways in which metaphors can be embedded deeply and implicitly in a visualization that would otherwise seem primarily schematic. This flow chart plots the evolution of the 2008 financial crisis through two narratives that develop over time. The narratives are composed of sequences of events that overlap chronologically: one fuels a speculative frenzy while the other results in financial crisis. Both sequences of events are framed by two overarching metaphorical associations: green = proceed/safe; red = stop/danger.

Figure 2. "A Visual Guide to the Financial Crisis," Mint.com, November 13, 2008

As the sequence of events and actions accelerates, the background shifts from neutral (or possibly clear) blue sky to green, and then from blue sky to red. Analysis of this image hints at the underlying tension between factual information (or data) and the subjectivity of the metaphorical frame through which it is encoded and communicated. Because the viewer reads this graphic top to bottom, the crisis is identified with a descent or downward orientation. The frame emerges as a form of master narrative that directs the complexity of the data in deterministic and, data purists may claim, reductive ways. "Hybrid" visualizations of this kind point to the fact that maps of any kind are metaphorical: the question is not whether metaphors are present, but how apparent they are to the reader.

Figure 1, in contrast, is rich in explicit metaphorical content. Illustrating a man hanging onto the edge of a credit card by his fingertips, it is a dramatic representation of the feeling of financial "abyss" that many experience in their relationships to credit and to the credit industry. As in Figure 2, the red color signifies danger. The card/abyss is proffered by a disembodied hand, which represents the financial system as an impersonal, oppressive, and rigid machine. Rigidity and impersonality are further signaled by the geometric, mechanical rendering of the line that outlines the shapes and by the contrasting scale between the big man/big hand and small man/small hand. The article accompanying the illustration explains how banks arrange the order of debit card transactions at the end of the day to maximize the number of times that the customer can be charged overdraft fees.

The narrative suggested in Figure 1 does not lie in the depiction of a linear sequence of events; rather, it appeals in a visceral and emotionally-laden way to the viewer's anxieties surrounding excessive debt, bank practices, and financial insecurity. Its explicit use of metaphor is crucial to understanding how this image functions, because the associations arising from the metaphor frame the financial content in ways that affect the viewer's interpretation of the image and the way credit is subsequently viewed.

Besides asserting that the depiction of emotional content *is* information visualization (of a very different kind from data visualization), the authors also contend that the supportive role of metaphor in conveying emotional content—present in these kinds of information visualizations—has been insufficiently studied, primarily because analyses of metaphorical devices have focused historically on their written and oral forms. More recently, interest in the formal aspects of visual and other representations of metaphors has broadened to include multimodal forms (Forceville 2010). One key to understanding the impact of metaphors in narrative visualizations of the kind shown in Figure 1, however, is conceptual metaphor theory.

Conceptual metaphor theory

Conceptual metaphor theory grew out of the seminal work by George Lakoff and Mark Johnson who asserted that metaphors are primarily a product of perceptions about the world rather than a product of language. In *Metaphors We Live By* (Lakoff and Johnson 1980), they argue that metaphors structure the way individuals think, and that many metaphors have their origin in physical experiences in the world. They analyze families of metaphorical associations around ideas such as "life is a journey" and "argument is war" to demonstrate how these metaphorical phrases both shape and are shaped by the way humans conceptualize different aspects of their lives. Of particular relevance to financial visualizations are the "orientation" metaphors that underlie ideas such as "up" is good and "down" is bad. As Lakoff and Johnson suggest, these associations may have arisen because of humans' physical stance in the world: facing the world from a vertical position, so lying down is associated with illness or weakness. Regardless of the origin, the association of up-as-increase pervades how individuals "read" information, and how they organize their visual schema. Quantities are graphed along a vertical axis in which up is associated with more and down with less; similarly, the phrase "GDP is up" connotes positive change. Conversely, the metaphorical phrase "falling into debt" denotes imminent peril (as reinforced visually by the dangerous position of the protagonist in Figure 1).

The metaphors used in narrative visualizations thus do more than provide convenient visual symbols for abstract concepts. They draw upon and reinforce existing conceptual frameworks. The use of the credit card to represent a potential financial/physical abyss in Figure 1 is made more powerful by the conceptual (and experiential) association of "falling" with "danger" and our likening the feeling of being in debt with that of insecurity. The strength of these associations encourages the viewer to "buy into" the framing implied by the visualization ("credit is dangerous"), and this ultimately influences both the way the viewer thinks about personal credit and the way he/she subsequently behaves. This last claim is supported by recent research in the field of behavioral economics, which examines how individuals form judgments and make decisions about financial and other aspects of their lives..

Behavioral economics

The neoclassical model of economics assumes individuals have unlimited information, resources, time, and know-how, which they use rationally to determine optimal decisions. In contrast, behavioral economics draws on results from clinical experiments on decision-making: these experiments conclude that individuals tend to rely instead on a series of simple heuristics (or rules of thumb) that codify ingrained habits of thought and systematic biases. One factor critical to this less-rational decision-making is the way that choices are framed. In "The Framing of Decisions and the Psychology of Choice," (Tversky and Kahneman 1981), Amos Tversky and Daniel Kahneman assert that reliance on frames to interpret information and to make decisions is both significant and empirically verifiable: when the frame shifts, so do decisions. "[B]ecause the value function is steeper for losses than for gains, a difference between options will loom larger when it is framed as a disadvantage of one option rather than as an advantage of the other option." (Tversky and Kahneman 1981, p. 211).

The economist Richard Thaler describes this theory in the context of consumer behavior using the following example:

> …credit card companies banned their affiliated stores from charging higher prices to credit card users. A bill to outlaw such agreements was presented to Congress. When it appeared likely that some kind of bill would pass, the credit card lobby turned its attention to form rather than substance. Specifically, it preferred that any difference between cash and credit card customers take the form of a cash discount rather than a credit card surcharge. This preference makes sense if consumers would view the cash discount as an opportunity cost of using the credit card but the surcharge as an out-of-pocket cost. (Thaler 1980, p.45).

Individuals' reliance on the "frame" to make decisions is analogous to reliance on visual perspective to make judgments about relative size and position when navigating physical space. As Tversky and Kahneman note (1981: 457), "changes of perspective often reverse the relative apparent size of objects and the relative desirability of options." Changes in the visual framing of situations can reverse an individual's thinking about the relative merits of two positions.

Metaphors also create frames and encourage changes in perspective, articulating what Donald Schön and Martin Rein in "*Frame Reflection: Toward the Resolution of Intractable Policy Controversies"* (Schön and Rein 1994) refer to as "cognitive frames." Consider the two narrative visualizations in Figures 3 and 4. These illustrations have a common subject—that of US taxpayers' "rescue" of the federal mortgage associations, Fannie Mae and Freddie Mac—but the framing of each is quite different.

Figure 3. "Bailout," Joe Barbee, September 7, 2008

Figure 4. Bailout cartoon, Heng Kim Song, 2009

In Figure 3, Fannie and Freddie are depicted as the arms of a drowning man needing to be saved ("thrown a lifeline") by taxpayers. In this illustration, the taxpayer is rescuing the insolvent Freddie Mac and Fannie Mae. The text in the first, "we need a bigger boat," aligns with the neoclassical model of logical decision-making in that it makes an essentially rational appeal for more capitalization. In contrast, Figure 4 depicts the taxpayer not as empowered rescuer, but as hapless victim. The taxpayer (shown as a boat) is imminently threatened by Fannie Mae (overweight individual), while Freddie Mac, equally overweight, passively waits to be rescued from the roof of one of many "underwater" houses.

The significant frame shift between the two images is the ways in which these agencies are understood. In the first illustration the reference point for Freddie Mac and Fannie Mae is represented by hands of a vulnerable man in urgent need of rescue; in the second Freddie and Fannie are seen as perhaps equally in need of rescue, but undeserving of it, putting their own survival selfishly and recklessly ahead of that of both the underwater homeowners and the U.S. taxpayer. Put another way, in Figure 3 Fannie and Freddie are most at risk; in Figure 4 the U.S. taxpayers are most threatened.

Illustration's historical importance as a medium for political persuasion is something of a testament to its capacity to shift frames (reference points, perspectives, and points of view) through extensive use of visual metaphor.

Two systems thinking

The "two systems" approach to understanding cognition was postulated by psychologists Keith Stanovich and Richard West (Stanovich and West 2000), and later elaborated by others (c.f. Wim De Neys 2006). In *Thinking, Fast and Slow,* Daniel Kahneman (Kahneman 2011) outlines the differences between what he terms System 1 and System 2 thinking which the authors summarize in the following table:

System 1	System 2
Intuitive fast automatic **effortless** *without voluntary control*	**Analytical** slow careful **effortful** *requires high degree of voluntary control*
System 1 is particularly good at comparing, averaging, identifying surprises from normal expectations, gauging intensity levels of attributes, and representing sets (of data) as prototypes and norms.	**System 2** is particularly good at computational tasks: sums, correlations and statistical tasks. It catches inconsistencies and anomalies in System 1 thinking, but will only be deployed when System 1 thinking encounters a problem it thinks it can't solve.

Table 1

System 2 thinking is analytical: it requires a careful consideration of details, and an ability to work through and rationally weigh all the options. System 1 thinking is based on heuristics and on intuitive understanding of situations. System 1 thinking is also lazy: as Kahneman notes, thinking rationally is hard work:

"(we) gravitate toward the least demanding course of action (because) in the economy of action, effort is a cost, and the acquisition of skill is driven by the balance of benefits and costs. Laziness is built deep into our nature" (Kahneman 2011, p.35)

When faced with new information, System 1 thinking creates a fast holistic picture of the situation, often relying on metaphors (whether verbal, conceptual or visual) to provide a rapid sizing up. It uses metaphorical framing to guide the individual's interpretation of the situation and subsequent actions. When comparing narrative visualizations such as those in Figures 3 and 4, System 1 thinking supports metaphorical framing to guide the viewer to consider Freddie Mac/Fannie Mae in two very different ways.

Narrative visualization

The authors assert that visual metaphor is central to the effectiveness of financial communication through narrative visualization for the following reasons:

i. By being visual, illustrative metaphors engage perceptual intuition. Color, texture, the angle of a gaze, the tilt of a head, all offer very subtle yet unmistakable cues that are understood at the very instant they are perceived. System 1 thinking is primordial: it will instantly detect a sharp look, a change in the environment, or a subtle variation in tone of voice. It does this extremely quickly (often in a fraction of a second), and is

therefore a cognitive function whose development is strongly related to survival reflexes.

ii. By being metaphorical, illustrations require little new skill acquisition and investment. Conceptual Metaphor Theory demonstrates that individuals already have an available storehouse of embodied understandings of the world (the learning completed since childhood) and additionally have an equally vast repository of the sociocultural understandings gleaned from thousands of hours of listening to others, playing, interacting socially, watching television, acquiring language, and being schooled. By activating associative memory, metaphors allow individuals to access what has already been learned (with considerable effort) and to bring together these elements more effortlessly in new configurations and contexts.

iii. Visual metaphors are effective in helping viewers to change a perspective or point of view. These metaphors do not only have the capacity to inform, but to influence; therefore, in combination with an increased capacity to process cognitively, they also have the capacity to alter attitudes and behaviors.

The next part of this paper presents two pedagogical examples from a design class in which narrative visualization principles were taught, and an evaluation of these examples using the infoEmotion© matrix: a prototype framework for the analysis of narrative visualization.

Part II: Narrative Visualization and Design Education

Design 4: A case study

PURPOSE

In the Design 4 course at Parsons, students acquire the basic communication-design skills for engaging and informing through visual means. A dedicated section of this course in Spring 2012 encouraged students to extend their inquiry toward using design and metaphor to influence behavior.

CONTEXT

Parsons the New School for Design offers a wide range of design programs, but also an undergraduate management program that awards a Bachelor of Business Administration degree. The Strategic Design + Management program teaches design-infused management skills to students interested in the application of design-oriented innovation to the operation of business.

In the first two years of the program, students take courses in economics, social theory, marketing, statistics, art history, and written communication, as well as a four-course sequence of design studies. This design studies sequence is intended to enable students to evidence a synthesis of design with management as they progress to the upper levels of their degree program. The final course in the design sequence—Design 4—is a continuation of "Design 3: Visual Organization and Information Design," with an

emphasis on the latter. Students explore information design by examining and creating visual communication in the form of page layouts, diagrams, charts, pictograms, maps, and instructional materials. The class is studio-based and draws upon previously-acquired design and technology skills.

In Spring 2012, The Visualizing Finance Research Lab offered a topic-specific section of this course, called "Design 4: Visualizing Finance," asking students to consider questions such as "How can information design be used to make sense of a complex world? How can we evaluate data, events, processes, and organizational systems visually? How can information design inform good (and bad) decisions? How can it be used to learn something new, tell stories, and build awareness about ourselves and the world we live in?"

"Design 4: Visualizing Finance" was a modified section of the Design 4 course, which was originally configured to teach information design conventionally: through the graphical representation of data. The explicit purpose of the Visualizing Finance modified course was to teach "narrative visualization." This was an ambitious goal: first because a course based on conventional information design should ideally precede one based on narrative visualization, and second because narrative visualization demands a variety of complex interpretations and analyses, the totality of which are difficult to accomplish within fifteen three-hour weekly class meetings.

The course assigned three projects; the first two were intended to provide a quick foundation of basic principles. The first project was a "data self-portrait" to articulate and cross-reference quantitative (numerical and countable) factors within aspects of the student's life (e.g., food consumption, utilization of time, budget). This required primary data gathering—such as accumulation of receipts and recording of events—as well as analysis, coding, and categorization into basic typologies of activity. Visualizations of these data were ideally encapsulated within metaphors that referred, more or less directly, to the student, although in practice this final requirement was seldom accomplished. The second project was a narrative consisting of "key frames" or single events, arranged sequentially to tell the stories of the students' passage from awaking to their arrival in the class at midday. The purpose of this was to familiarize the student with the editing process of converting longer narrative chains into a succinct and selective sequence of key events, and to present these events in a visually and emotionally engaging manner.

The third and principal project was creation of a brief video or animation depicting a financial decision-making process and incorporating data and financial concepts. This represented The Visualizing Finance Research Lab's first attempt at implementation of some of the design insights described in this paper, beginning to develop and test a methodology for creating narrative visualizations in both academic and professional contexts.

Collaboration

For this final project, the Design 4 class partnered with a class called "Personal and Consumer Finance," which was taught at The City University of New York's professional-development evening school for working adults. This CUNY course is designed to train community leaders to work as financial counselors with individuals in various underserved populations, especially with immigrants and the economically disadvantaged.

This partnership encouraged Design 4 students to a more user-centered design process by "spending time with users/citizens in their own environments, rather than

working on a project abstractly in another space" (Chick 2012, referencing Manzini, 2006; Thackera 2007; Pilloton 2009), and by recognizing the expertise that resides in those whose interests are affected by the problem and its proposed solution (Chick 2012).

The counselor-training partnership provided context and content for the design students in several ways:

- acquainted students with populations different from their own
- required students to recognize and incorporate cultural and socioeconomic factors outside their own experience
- gave students live/simulated dynamic representations of financial behaviors and decisions
- provided a story line based on financial counselors' experience with target audiences

The CUNY course can also be seen as a consumer/client for the completed student work: materials that were intended to be responsive to user needs by being

- culturally relevant to the target populations
- richer and more emotionally engaging than existing informational materials
- available to individuals and for use in counseling, education, or training sessions

The partner's expected field usage of these materials can in future provide opportunities for critique from trainers, practitioners, and end users; also opportunities for assessment of the materials' effectiveness.

Background of Partner

The "Personal and Consumer Finance" course at The City University of New York was originated and developed over several years by Ms. Joyce Moy, an educator/activist/attorney who has extensive experience developing support structures for underserved populations. Ms. Moy has written a course-specific textbook that makes substantial use of practical examples, scripts, and role-plays drawn from the experiences of Ms. Moy and of financial counselors. In several class sessions, the CUNY students engage in a role-play that simulates a counseling session on a specific financial topic and on related behaviors. Each role-play is a complex and multifaceted encounter, organized in a narrative form to train the counselors across the multiple dimensions required of them in a professional context. These dimension include

- empathy and interpersonal communication (present in body language, tone of voice, and verbal choices for dialog)
- command of information and reference to available resources
- analysis of data, financial analysis, and planning
- decision-making ability
- ethical/legal integrity

The simulated session is then discussed by the instructor and remaining class members, assessing the counselor's emotional intelligence and command of factual information, as well as the psychological and cultural factors involved in the clients' problems, behaviors, and possible solutions.

Methodology

Selected students from the Design 4 class visited the CUNY "Personal and Consumer Finance" class on several occasions: first as observers, familiarizing themselves with the

target populations, some financial concepts, and the purpose of financial counseling. In a subsequent visit, the Design 4 students and instructor videotaped a simulated counseling session.

Figure 5. Video still from financial counseling role-play, "Fin 180, Personal and Consumer Finance" The City University of New York

The role-play scenario concerned a young couple who are visiting the financial counselor because they want to marry; however, the man's father had accumulated credit card debts in the son's name and the son's credit score was badly compromised. This situation was affecting the couple's decision to marry, and potentially affecting the couple's plans for a family and home of their own.

Back in the Parsons Design 4 classroom, students were provided with a printed version of the role-play scenario and with uploaded versions of the video. The students formed groups of two or three to process the information in the role-play and to draft narrative and visual strategies for the interpretation of the material. The instructors from The Visualizing Finance Research Lab provided a brief explanation of the financial content and context of the role-play. Students were then asked to present financial concepts directly through explication (text, graphs, and dialog), and metaphorically through the creation of characters, settings, and a narrative story line. Specifically, students were required to create a narrative, time-based representation of the financial role-play, which identified and incorporated both content elements and visualization elements:

Content Elements
Financial factors:
- Data and information, such as numbers, budgets, facts
- Concepts: time value of money, negotiation, legal information such as policies, loan terms, etc.

Behavioral aspects:
- Consequences: financial and emotional
- Negotiation and decision processes: skills, strategies, and methods
- Ethics: the right/wrong thing to do
- Culture: norms, expectations, and understandings within a community
- Emotion: personal and subjective factors (relationships, loyalties, opinions)

Visualization Elements

- Graphs/maps
- Text: on-screen text/data
- Dialog: monologue, verbal explication, through characters or voiceover
- Setting: staging, including objects and props
- Character: including archetype(s)/metaphor(s)
- Body language, expressed by character(s)
- Facial expression, expressed by character(s)
- Tone of voice, expressed by voiceover and/or by character(s)

It has only been on reflection that the authors have been able to synthesize these elements, formulating them into a tool that we call the infoEmotion© matrix (Table 2). In this we have organized the Content Elements in descending order from generally more analytical (or System 2) to generally more intuitive (or System 1) elements. A similar ordering from left to right was used in the organization of the Visualization Elements. The matrix is a framework for analyzing and identifying the presence and intensity of the elements that constitute a narrative visualization of a financial concept. This intensity is visually represented in a range from absence of an element (indicated by blank space) to moderate presence (pale-gray filled circle) to high intensity (darker-gray filled circle). Table 2 also represents a range of elements typically seen in narrative visualizations in the media, in financial education materials, and in student work. The authors are currently using the matrix to identify the relative presence or absence of these elements, and Table 2 should be viewed as a rough approximation of a typical narrative visualization.

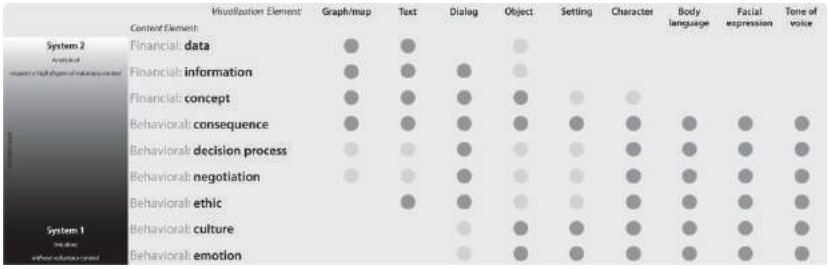

Table 2. Visualizing Finance Laboratory infoEmotion© matrix

Our matrix does not address genre or other external factors because it was developed only to identify content and visualization elements that drive a narrative visualization. Metaphor is implied throughout Table 2: it has the ability to fill the blank spaces in the matrix and to create bridges between the content and visualization elements in each axis. Metaphor can communicate a financial concept in the form of a character as in the example of Figure 4, in which the metaphor of a "bloated bureaucracy" is expressed visually in the character of Fannie Mae as an overweight woman.

Use of metaphor helped students to strike an appropriate balance between narrative aspects (dialog, situation, and emotional tenor) and the practicalities (financial data and choice options) in their time-based narratives. Students came to understand that "real-world" financial situations incorporate a complex layering of frames—behavioral/emotional and cultural/familial, as well as the more pragmatic or

information-based—and that these situations often arise from decisions that are intuitive rather than analytical/rational. Experienced financial counselors can attest that while each scenario may have certain similar elements (family expectations, distrust of financial institutions, avoidance of reality, overconfidence in ability to "deal with it" etc.), yet each scenario cascades into a plethora of (often unforeseen) financial consequences.

The Parsons students had to make decisions about how to condense a 12½-minute role-play into a 3½-minute clip. They reprioritized information, condensing some aspects while allowing time to elaborate on others. The design students also had to make decisions about the type of story they were crafting—the characters, settings, and props—and the way these were activated within a narrative arc. They found the development of characters to be a complex process, necessarily intertwined with the physical setting of the story.

In the analysis below, the authors have selected two student projects that engaged the infoEmotion© citeria for narrative visualization. By testing subjectively-held opinions about the projects (those to which the instructor had assigned grades in the A range) against the infoEmotion© matrix, we are able to assess the works' success in fulfilling criteria for complete narrative visualizations with more precision.

Outcomes

Project 1 is a 3:12-minute key-frame partially-animated narrative with sound and voiceover. The visual style uses simple vector-based graphics (similar to those used in the television animation *South Park*) over photographic montages that range from the interior of a church to a collage of credit cards. Some personae are represented metaphorically in memorable ways: Tom as a frightening vampire and Tom's father as a blood-sucking mosquito who drains (transforms) Tom's credit score. Eventually the students' efforts to resolve Tom's credit problem lead to a "brick wall," necessitating additional research.

Figure 6. Project 1: "Tom and Jen: A Credit Story," Brianna Morris and Elizabeth Shupe

Table 3 shows the infoEmotion© matrix that identifies the content and visualization elements present in Project 1; this assessment is elaborated in the text that follows.

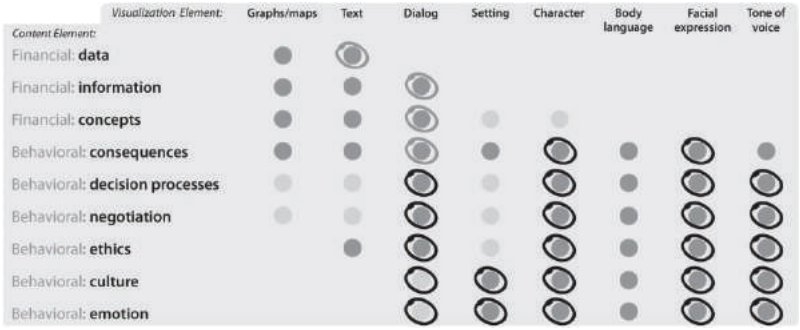

Table 3. infoEmotion© matrix for "Tom and Jen: A Credit Story"

Project 1 scored quite high on the Visualization Elements relating to System 1. Behavioral aspects are clearly communicated through the characters (the disappearing groom, the predatory father), their facial expressions, and their tones of voice. The visualization engages with financial concepts and behavioral consequences to a limited degree, but is slight to nonexistent on imparting financial information and data. The viewer never learns, for example, how a credit score is calculated, what credit-score numbers mean, and what the consequences of having a low credit score are. Stronger aspects in this project were the (metaphorical) personification of Tom's father as a mosquito, and the very ethnically and culturally relevant characterizations and setting of the story line. However, the lack of props and other design elements that would indicate more specificity in the setting (further underscoring cultural factors) were a missed opportunity, as was the lack of articulation of the character's bodies thereby limiting their expressive ability. Other deficits were the lack of financial data and lack of detail in the financial information.

Project 2 is a 3:32-minute key-frame partially-animated narrative with sound and voiceover. The visual style combines the same vector-drawn characters as Project 1, but adds marker-pen lines (reminiscent of the "whiteboard" graphic style of RSA Animate) on a background of graph paper.

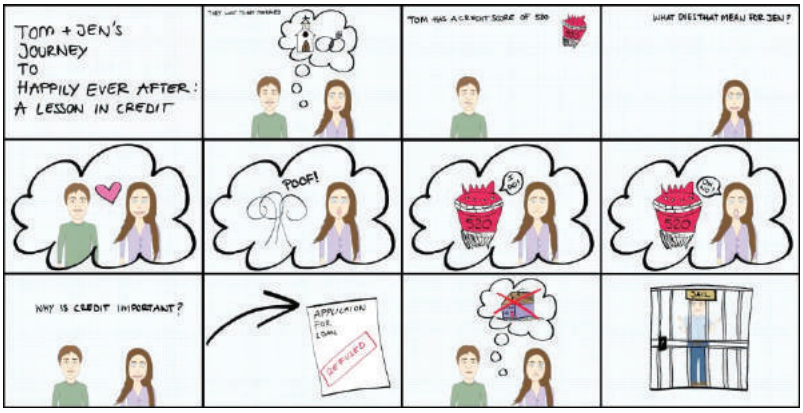

Figure 7. Project 2: "Tom and Jen's Journey to Happily Ever After," Caitlin McDonough and Prisca Bommeli-Kasser

Table 3 below and the following text analyze the content and visualization elements present in Project 2.

Visualization Element: / *Content Element:*	Graphs/maps	Text	Dialog	Setting	Character	Body language	Facial expression	Tone of voice
Financial: **data**	●	◉						
Financial: **information**	●	●	◉					
Financial: **concepts**	●	●	◉	○	○			
Behavioral: **consequences**	●	●	◉	●	◉	●	◉	●
Behavioral: **decision processes**	○	○	◉	○	◉	●	◉	◉
Behavioral: **negotiation**	○	○	◉	○	◉	●	◉	◉
Behavioral: **ethics**		●	◉	○	◉	●	◉	◉
Behavioral: **culture**			○	●	●	●	●	●
Behavioral: **emotion**			◉	●	◉	●	◉	◉

Table 4. infoEmotion© matrix for "Tom and Jen's Journey to Happily Ever After"

Project 2 earns a similarly high score on the behavioral content elements relating to System 1, with some exceptions, and a similarly lower score for the System 2 financial content elements. The behavioral aspects (as in Project 1) deploy multiple visualization elements both sequentially and simultaneously, with System 1-related elements far richer and more nuanced. The characters' facial expressions in Project 2 are more varied than those in Project 2; however, unlike Project 1, its metaphorical language is confined to the "low credit gremlin," the evaporating fiancé, and devices such as the "thought bubble." The key point of difference between this example and Project 1 is Project 2's greater deficit of specific cultural import in the characters, making little reference to the ethnic or cultural demographic evident in the role-play script and video. In addition, due to the graph paper environment that the characters occupy, the setting does not contribute to behavioral elements.

Although both projects are engaging and effective, the infoEmotion© matrix highlighted shortcomings common to both. Key shared deficits were in the explanation of financial concepts and the amplification of financial data. Both projects also missed

opportunities to explain financial factors using prop-based examples (setting) or by building contextually immersive situations.

Findings and next steps

The authors have found the infoEmotion© matrix invaluable in identifying the elements that are emphasized or overlooked in the two visualizations evaluated in this paper, but clearly the matrix is a prototype and there is more work to be done. By the time this paper is published the Design 4 class will have run again (Spring 2013). This will have given The Visualizing Finance Lab the opportunity to integrate the infoEmotion© matrix explicitly into the development phase of the students' projects and to test the content and visualization elements against the characteristics that emerge in this new group of visualizations. In the longer term we hope to use the infoEmotion© matrix as the basis for an assessment rubric for student narrative visualizations.

We anticipate that the infoEmotion© matrix will also prove useful in better assessing how published narrative visualizations depict financial information. In Figure 1, for example, the primary message involves financial concepts (the nature of credit) as they are manifested in behavioral terms, through emotional factors. These ideas are delivered largely through setting, character, body language, and facial expression.

A number of important and unanswered questions that arose during the class have not been addressed in this article. These questions largely concern socioeconomic and cultural factors, e.g., How do the ethnic and socioeconomic identities of the characters affect the message? What is the impact of nonhuman characters (e.g., the Geico lizard) in communicating sensitive but important information? What are the roles of other popular cultural signifiers (such as recognizable symbols and humor-driven references)? These questions lie at the heart of the design problem and they drive issues of visual styling and art direction.

Conclusion

The authors assert that narrative visualizations can be a powerful tool in increasing financial literacy, and that designers can play a substantial role in this effort by developing visualizations that relate to "System 1 thinking" (Kahneman 2011). Through an overt reliance on metaphors, narrative visualizations can communicate financial concepts in a way that highlights their intuitive and emotional consequences. Narrative visualizations provide designers with a wider range of methodologies than more-traditional information visualizations: methodologies that engage the behavioral-cognitive dimension of financial literacy in a rigorous and systematic fashion. From the financial literacy perspective, work still needs to be done in codifying key design elements across a range of existing financial literacy contexts and materials and in testing their effectiveness; to this end, the infoEmotion© matrix is a beginning. From the perspective of the design educator, we believe that narrative visualization methodologies are an important part of a contemporary design education: one that has many applications beyond financial literacy.

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