Data Visualization and Assessment: A Speculative Overview

by

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Abstract

Comprehensively representing learning and knowing in visual arts education continues to be a challenge to the field. In this article, the author shares an overview of uses, concerns, and speculations regarding the possibilities that data and artistic visualization may bring to the process and implications of assessment in art education.

There are many and varied ideas, approaches, purposes, and challenges associated with educational assessment and evaluation. The idea of data visualization in art education assessment may problematize our current understanding of what assessment and evaluation mean. Indeed, monitoring, reporting, or measuring the processes and innovations involved in art learning and making do not necessarily result in quantitative data. As the ways of working in art are mostly visual so should the means by which they are assessed be represented in visual ways.

Data visualization and assessment

David McCandless (2014) explained that the data visualization process is just that—a process—that helps the viewer visualize the how and the why. He also suggested that data visualization should both reflect and compel deep understanding and engagement. In his book *Knowledge is Beautiful*, McCandless (2014) explored the relationships and patterns among numbers, ideas, facts and world-views.

Brigham Young University professor David Wiley's (2010) visualization entitled "Waterfall" featured a vertical axis that represented students' final grades (higher final grades at the top). The horizontal axis stood for time, with each cell corresponding to a day in the semester. Each individual row represented an individual student. Finally, the darkness of the water droplet signified the amount of time that a student spent on a particular day completing gradable activities. They called this visualization "*The Waterfall* because the drops all but evaporated away by the bottom of the image (meaning that students with lower final grades spent much less time on their work), reinforcing what we know about the relationship between time-on-task and academic performance" (para. 3). (See http://opencontent.org/blog/archives/1286)

Art educators Lihua Xu, Read Diket, and Tom Brewer (2015) examined the ways that the 2008 National Assessment of Educational Progress (NAEP) in visual art captured the thought processes by which students successfully approached visual analysis and interpretation of meaning. The constructs/concepts/categories they tested for with the NAEP were art knowledge, technical skill, aesthetics, and meaning making.
Their visualization entitled *Aspirational Model* represented the degree to which the students' analyzed mother/child portraits of different genres. The researchers developed or identified indicators of excellence or success as 1) text on the chart: explain where artists used light and shadow to create realism; 2) explain how artists used light to create lack of realism; 3) style that contributes to developing 20th century Cubism; 4) identify 20th century work; 5) identify the style of art as surrealism; and 6) continued focus on realism by study of details. The y axis represented the relationship of a particular item

with overall student achievement scores, and x axis indicated a growth or building of artistic understanding through four constructs. (See http://www.slideserve.com/lilly/mixing-authentic-and-large-scale-visual-arts-assessment-what-might-work-for-you-thomas-brewer)

Assessment through and with visualization relative to new data dynamics in education drives art educator Chris Grodoski's work with several IBM architects, programmers and technology assessment specialists. They developed a data model for formal assessments that used visualization to assess through comparative rankings and dynamic benchmarking. Instead of visualizing assessment, this project used visual interfaces *for* assessment. "The aim of this *ratecreative* project was to keep the big data ambitions of those outside of art education at bay in developing arts education assessments from those within the field- including the classroom. This work includes strategies for organizing benchmarked information to individual standards and selecting previously rated work within larger quartile categories to share with students, as well as use for teacher planning" (C. Grodoski, email communication, 1/24/2015). (See www.ratecreative.com)

A leading researcher in the field of visualization is Charles Xie. Xie is a physicist by trade, studying and developing visualizations relating to energy, engineering, and molecular simulation of evaporation and condensation. Of particular interest to this research is Xie's work at the Concord Consortium related to learning sciences, data mining, learning analytics, and performance assessment. His work draws from educational data mining. He is spearheading visual and learning analytics for educational

research and assessment of complex engineering design. Xie's work is especially significant to identifying what to look for when mining relevant and meaningful data in art education. Xie (2014) wrote, "To see structures in data, researchers must first define the indicators for measuring student performance, proving a hypothesis or capturing a cognitive response" (para. 13). (See https://concord.org/about/staff/charles-xie)

Many art assessment strategies rely heavily on the standards of learning from which to identify performance indicators (Brewer, 2011; CSDE, 2015; Diket & Brewer 2011; Taylor, 2014; Xu, Diket, & Brewer, 2015). But, as Diane Ravitch (Ravitch in Neufeld, 2014) so eloquently stated: "Sometimes, the most brilliant and intelligent minds do not shine in standardized tests because they do not have standardized minds" (para. 5). According to Charles Xie (2014), there are patterns of learning that can be aesthetically visualized. Data visualizers Julie Steele and Noah Iliinksy (2011) wrote that the primary consideration of a data visualization formulation should be about good storytelling first and aesthetic considerations second (p. 12). Dutch visualization theorists Sundvall, Nystrom, Petersson, and Ahlfeldt (2006) affirmed that the aim of visualization is to reduce the cognitive effort required to understand abstract information by engaging human visual perception systems. Sets of data can be retrieved through queries called focus sets. Could focus sets represent exactly what a student does when and where? Or, as University of North Carolina computer science scholars Matthew Johnson and Tiffany Barnes' (2010) called "Watching students learn," what if we could visualize the process of problem solving in art and artmaking?

Traditionally, in visualizing procedural problem-solving, teachers may look for technique and process. Perhaps even more importantly are students' innovation and creative problem-solving approaches that include deviation from the expected or predictable. How would one locate deviation? How can we formulate queries for mining data that relate to concepts, descriptions, and relations? What symbols and patterns might one use in a visualization to represent such data?

What if a visualization could show the path and the amount of time spent in one place while doing such tasks as: reading, sketching, making notes, doodling, redrawing, and thinking? And similar to what Charles Xie (2014) refers to as "digital traces," how could such a visualization be inclusive of a student's work and links among any and most other web tools? How could it track and visually represent the research and thinking that make up a student's learning processes?

Possible examples of visualizations that may represent traces of art learning could include specific views of student work in the beta eLASTIC software environment (Taylor 2014, 2015). The eLASTIC virtual artist studio and gallery spaces were filled with objects used to house students' images, text, sounds, and video clips that could be linked among other information in the environment. Students selected portions of the images and text and created links among objects. The links were depicted as lasers (color-coded according to student specified paths such as technique, idea, social issue, and/or context). The different views—overhead view that looked much like a map; explorer view that mimicked a diagram; and 3-dimensional room view, could be perceived as visualizations. (See

www.elastic.vcu.edu)

Then again, digital traces of students' art learning are not restricted to only their engagement with one virtual environment. Researching, learning, and artmaking proficiencies are evidenced across a plethora of devices, media, platforms, web sites, and venues. *IO Graphica* is a computer application that will trace mouse movements on a computer screen for an unlimited amount of time. Though not statistically-based, the colors, sizes, shapes, and dizzying array of lines can be an artistically pleasing representation of one's computer use. (See http://iographica.com/)

Diigo (Digest of Internet Information, Groups and Other stuff) is a multi-tool Internet application designed to streamline Internet workflow by enabling annotation and tagging of text, images, sound and video found on websites. (See https://www.diigo.com/) Art educator and researcher Karen Keifer Boyd (2012) used this free social networking application in her transcultural dialogue project involving art students at Makerere University in Uganda and Penn State University. The students "bookmarked websites with Diigo and saved the Web bookmarks to our Diigo group forum. Diigo enables the layering of virtual post-it or sticky notes on a website, in which, similar to a blog, many can comment on each other's ideas" (p. 256-57).

Monitoring software systems are available to assist employers with watching employee productivity, parents with checking and ultimately supervising their children's Internet usage, and marketers with observing social media behaviors. Although the software

intentions contrast starkly with the kinds of authentic and empowering forms of assessment proposed or hoped for in this article, there are some features of monitoring software systems that may be applicable to a discussion regarding digital traces. Such monitoring could assist in understanding how a student may have come to an idea by following the route to and from which a student moves around not only the Internet but also their engagement with artmaking and word processing software. What if the amount of time a student looked at a particular image, where their mouse was tracked, what they copied, pasted, or altered while working could be documented and visibly represented? Perhaps, too the recording capabilities of monitoring software could be coupled with the lines of connectivity of such applications as *IOS Graphica* to create an eLASTIC-like overview of where and what students are researching and being influenced by online. Monitoring software typically traces, records and reports such statistics of what websites are being viewed and what applications are being used, as well as the amount of time users are spending on those sites and applications. Monitoring software generates productivity reports in the form of spreadsheets, screen shots, and narratives. (See http://abcnews.go.com/GMA/story?id=7434768) Possibly the method of graphing, producing tables, charts, and/or dashboards could be used for the data collection needed to create authentic art-learning visualizations. The next step, though in this speculative process would beg the question, how can such endeavors be and make meaningful art? Can a data visualization be artistic?

Artistic data visualization

Artistic data visualizations, according to Fernanda B. Viégas and Martin Wattenberg (2007) "are [simply put] visualizations of data done by artists with the intent of making art" (p. 18). Viégas and Wattenberg stipulate that in order for an artwork to be classified as a visualization it must be based on actual data and not solely be concerned with beauty, aesthetics or visuality. In their research and brief survey of artistic information visualizations, they examine the ways that "artists appropriate and repurpose 'scientific' techniques to create pieces that actively guide analytical reasoning and encourage contextualized reading of their subject matter" (p. 182).

According to Viégas and Wattenberg, the value of data driven artworks rests on the fact that their creators recognize the power of the visualization to express a point of view (p. 190). The artists can purposefully choose for example, a particular perspective, color, or proportion to promote an idea or emphasize some features over others. Granted, artist data visualizations may not be the neutral analyses touted by such hardcore visualization pundits as Edward Tufte (2006). But, as Viégas and Watterberg (2007) remind us, "There are valid reasons to want to change the way people think and it may be that much of the value of visualization comes from its ability to change attitudes" (p. 191). Traditional forms of data visualization such as infographs, concept maps, and/or charts are created using averaging, panels, dashboard displays, graphs of nodes and links, and webbing techniques. Although artistic visualizations draw from these traditional techniques, they rely more upon the use of visual metaphors and other artistic tools of visual expression.

Visualizing artistic learning

What might an artistic data visualization of student learning in art look like? In an attempt to experiment with and perhaps illustrate some of these imaginings, I will share some data visualization experiences and speculations involving the use of visual service-learning reflective journaling in an introductory art education course. The pre-service teachers in this class work as mentors with an established program at a local at-risk elementary school. They are assigned one young student with whom they spend at least one hour per week doing homework, making art, engaging in conversation, playing games, and/or working on class assignments. The mentors work with the same young student throughout their time at the university—developing a strong bond and support system among the mentor/mentee and the university, school, and community. Group reflections of the experience are done online and in-class. The reflective journal was designed to provide the pre-service teacher with an individualized vehicle for critically pondering, exploring, connecting, and documenting their learning, service, and transformation in this experience. Criteria for evaluation of their journals included: 1) met deadlines; 2) link reflections to class work/discussions/readings/topics; 3) visually and metaphorically cohesive and understandable; 4) link with ideas and future plans as a teacher/leader.

A graduate assistant and I interpreted one of the student journals by marking, sharing, and making notes via Google slides. (See Figure 1.) I then took that information and created a file in a mapping software (*Tinderbox*) and took screen shots of several views that might

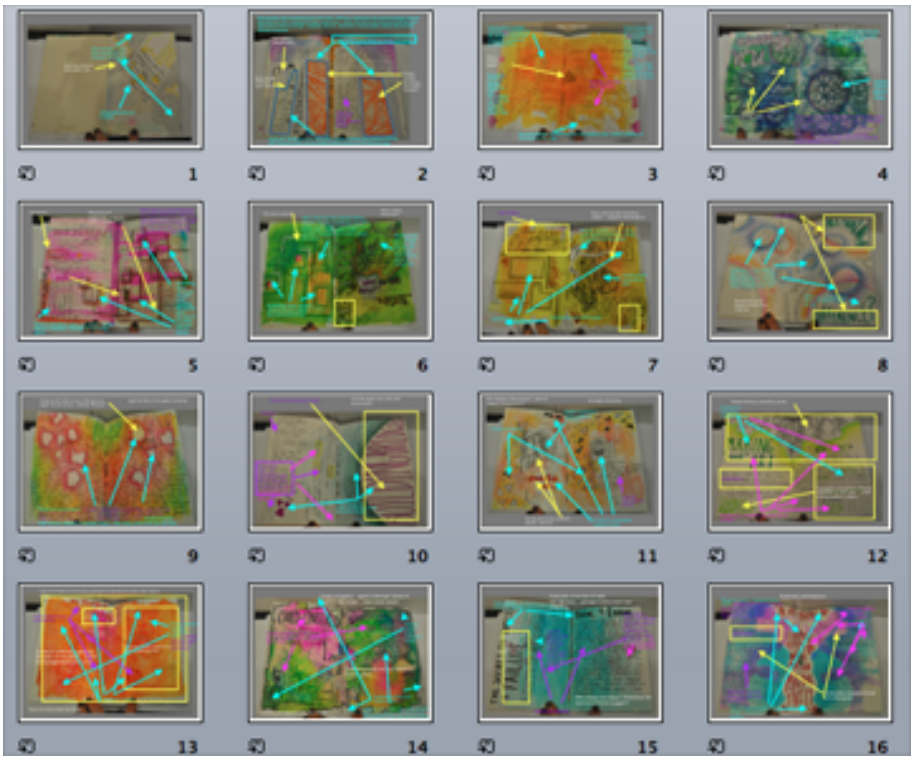

Figure 1. Student journal interpretation on Google slides using color-coded based upon: reflections to class work/discussions/readings/topics; visually and metaphorically cohesive and understandable; and ideas and future plans as a teacher/leader.

serve as a visualization of the data we specifically outlined. I also created a bulletin board-like visualization featuring images and notes using the *Liniot* network application. We then took the student's entire sketchbook, removed all color, and highlighted the areas that represented specific focus sets in colorized circles. Our multiple attempts illustrate David McCandless' (2015) idea of versioning: "Sometimes – actually most of the time, an information design goes through many versions. In a way, it's like sculpting. Whittling away excess material, trying to find the optimal design" (para. 1). Through making and remaking art, writing and rewriting, constructing and reconstructing, we continued to change and toy around with our data visualization attempts in hopes of it

either telling the story better or providing multiple ways for others to read the story of this student's service-learning experience.

One version involved looking at visual metaphors specifically related to the aforementioned Ravitch quote regarding the idea of "shining" minds. How might one represent the "shining" moments of reflections in the student's journal? Shining bubbles highlighted specific areas of the journal entries indicating the students connection with class work/discussions/readings/topics. (See Figure 2.) Twinkling lights emphasized areas the illustrated the student's ideas and future plans as a teacher/leader. Sparkling fireworks revealed areas that were visually and metaphorically cohesive and understandable.

Figure 2. Shining bubbles highlight specific areas of the journal entries where students connected their service-learning experiences with class work/discussions/readings/topics.

Dissatisfied with the static images, we speculated upon the idea of attempting an interactive form of a data visualization along the line of installation artists Romy Achituv and Camille Utterback's 1999 *Text Rain*. An interactive installation, *Text Rain* is actually shaped by its viewers. Their presence and actions in front of a large projection screen disrupt and direct the flow of falling letters.

> If a participant accumulates enough letters along their outstretched arms, or along the silhouette of any dark object, they can sometimes catch an entire word, or even a phrase. The falling letters are not random, but form lines of a poem about bodies and language. 'Reading' the phrases in the *Text Rain* installation becomes a physical as well as a cerebral endeavor (Utterback, 2015, para. 1).

What if a data visualization of art student learning was designed so that it could be shaped by its viewers? For example, areas with a higher degree of relevance could magnify, brighten or pulse with light to entice or challenge a viewer to select a path or criteria to follow. Perhaps a data visualization could be designed to engage parents, teachers, and administrators to learn from and contribute to student artists' processes. Like interpreting a work of art, their engagement may make the data visualization more than it was before they interacted with it—actually expanding the notion of assessment.

Shouldn't assessment contribute to, as well as tell the story of learning, knowing, teaching, and making in art? In what ways could data visualization be a factor in student learning or engagement? According to Xie (2014), the answer would lie in the tools we

use to gather, reflect upon, and create the data visualization—what he called "mind recorders" (para. 9).

Figure 3. A student created this critically reflective data visualization of her service-learning experience by combining images from her journal into a collage and re-presenting them according to 1) her vivid use of visual metaphors; 2) typical amount of links to class work/discussions/readings/topics; and 3) links with her vague and somewhat skeptical ideas and future plans as a teacher/leader.

What if students constructed their own data visualizations of their service-learning and used their reflective journals as tools? (See Figure 3.) In other words, what if the service-learning reflective journals were their mind recorders or remembrance devices from/on which they based their data? Then, perhaps their data visualizations could become artistic visualizations with meanings designed to change the way their viewers think (Viégas & Watterberg, 2007) about specific issues related to their service-learning experiences (ie: civic responsibility, social justice, and difference). Indeed, engaging students themselves in the data visualization task of representing or picturing their learning experience would involve them in a number of significant learning approaches including observation,

differentiation, and critical reflective and analytical practices in addition to technique and innovative methods of meaning making.

Summary

Because of its relative newness in the field, the effectiveness or even the feasibility of data visualization as an assessment practice may be debatable, to say the least. And yet, it continues to intrigue art educators because its very nature is so visual and often, so beautiful. When artistic data visualization theory is brought to the conversation, the idea that meaning and social change can possibly be a factor in education assessment may indeed be welcomed by art teachers whose mission above all else is engaging young people in meaningful learning and making of art. Hopefully, this initial overview, research and speculation of data visualization in art and art education may inform ways for envisioning and representing the complex learning associated with teaching and learning in the visual arts.

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