

Pandemic Pedagogy: Taking Data-Viz Learning Online

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Abstract— The pandemic has created significant teaching challenges for data visualization educators. Classroom-based hands-on activities don't readily translate into engaging online experiences. This paper lays out three guiding principles I used to make this transition - maintaining learning goals, embracing the affordances of available technology, and activating the learner's physical setting as part of the activity. I present two activities that I adapted to work online as case studies in how those principles play out - building data sculptures and sketching visual word webs. The three principles, case studies, and reflections offer insights and lessons to other educators designing and leading virtual activities with data visualization learners.

1 INTRODUCTION

Data visualization has become firmly established as a critical and increasingly mainstream communication technique for our data-centered times. It is being taught in multiple fields - from journalism [4], to undergraduate computer science education [7], to business schools [8] and more. Teaching data visualization is firmly established as a field of study and scholarship; in both 2016 and 2017 the IEEE VIS conference hosted workshops on the “Pedagogy of Data Visualization”.

In the midst of a global pandemic, how do we continue to deliver creative and high-quality learning experiences for data visualization online? This short paper introduces two case studies of how I have taken hands-on activities related to data visualization and brought them online. Their adaptation was guided by three questions:

1. Can the activity be moved online without sacrificing learning goals and pedagogy?
2. What parts of the activity might your technology support? What parts might it hinder?
3. How can you turn the students' physical space limitations into an opportunity?

I don't consider these to be radically new questions in the world of online teaching. I reiterate them here, in the time of a global pandemic, to reinforce that simply moving activities online as-is is unlikely to produce strong learning outcomes.

2 MOTIVATION

My approach to data visualization education is firmly rooted in principles of hands-on learning and constructionism [3]. I anchor my pedagogy in this central idea of Seymour Papert's - that learning occurs best when people are designing and discussing objects for audiences that are meaningful to themselves or their peers [6]. As businesses and campuses emptied and teaching moved online, I quickly began to reflect on what it meant to create constructionist experiences for data visualization learning in virtual settings.

My Data Culture Project (culture.databasic.io), a collaboration with Catherine D'Ignazio of MIT, already offers a set of participatory activities for learning various stages of the data visualization process. The dozen activities documented there function as a self-service curriculum online, used by tens of thousands across the globe to support learning in newsrooms, schools, non-profits, and businesses.

During the spring 2020 disruption I adapted and used two of the Data Culture Project activities in virtual classroom settings, as documented in the following sections. Each example pulls from my experiences this past spring taking my undergraduate/graduate university “Data Storytelling Studio” course online due to the pandemic. The class

included 18 students, meeting co-temporally in a Zoom room for 1.5 hours twice a week over roughly a third of the spring semester. Students came from various disciplines - business, education, public health, urban planning, engineering, computer science.

3 CASE STUDY 1: BUILDING DATA SCULPTURES

My “Build a Data Sculpture” activity invites participants to build a physical representation of a data story using familiar craft materials within 10 minutes. In prior work I argue that this activity is particularly well-suited to environments that benefit from a low-tech and playful introduction to working with data [1]. The primary learning goals include understanding physical variables, moving quickly from data to story, and interrogating the explanatory possibilities of a physical material.

As part of this semester long course I usually expand the activity to be a 2-week group project; with the rescheduling required due to class cancellations that become impossible. Guided by the 3 principles covered in the introduction, I ran through a few options for taking this activity online:

- (a) Eliminate it from my syllabus
- (b) Have students remotely collaborate while one builds
- (c) Have students build with their own materials at home
- (d) Mail students a standard box of materials to build with

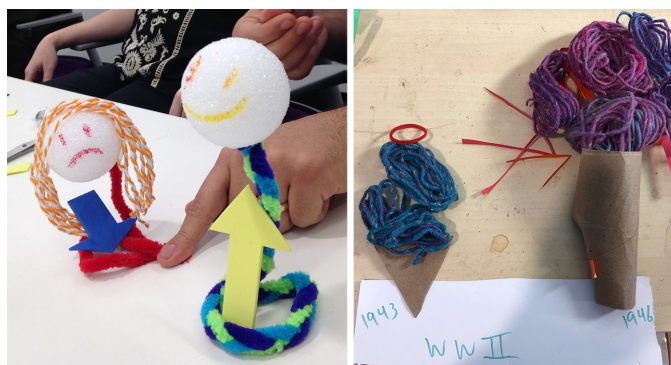


Fig. 1. Data sculptures created by students during in-class sessions.

After weighing the various options, I decided to have them build small data sculptures individually with whatever they found around them at home (option c). This option let me maintain my learning goals and pedagogy - they would still be quickly building a sculpture based on physical encodings with playful materials. To avoid technology getting in the way of the creative process, I asked them to post photos of their completed projects to the class blog (which would also support sharing and discussion). To connect the assignment to their interests, I asked them to work with a data story they had already created in one

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of the two previous group projects they had worked on. This approach also turned their physical constraints into a positive, because they each would have different materials around them and I hypothesized they would produce a diversity of approaches and projects.



Fig. 2. Data sculptures created by students attending class virtually from their own homes.

The students built data sculptures that showed far more creativity than when I run the activity in the standard way. I typically provide a set of craft materials for the activity along with a single data handout. Projects produced in class with these materials and data often look similar to one-another or use obvious representations - smiling faces for happy or sad people, ice cream cones for ice cream (see Fig. 1). With students using datasets they already knew, and using materials from their homes, the projects varied far more widely (see Fig. 2). One used the amount of salad toppings to indicate floral diversity in different parts of New York City. Another smudged a globe with dirty fingerprints to encode air pollution. A third built a model of a two-storey museum exhibit that portrayed accepted vs. denied US FOIA requests with a “tip of the iceberg” metaphor. As a whole, the sculptures captured each of Moere and Patel’s “symbolic, iconic and indexical” taxonomy [5]. Of course, this could also be attributable to the fact that they had more than 10 minutes to create the pieces - further study and iteration would be required to understand this more thoroughly.. These results lead me to believe that this approach to taking the data sculptures activity online met my criteria for success quite well; my plan responded well enough to my three guiding questions to produce evocative projects that provoked discussion.

4 CASE STUDY 2: SKETCHING A VISUAL WORD WEB

The “word webs” activity is used by artists to help move a group from an abstract concept to a larger set of words that describe it. In the data visualization process this can help transition from abstract concepts such as “power”, “justice”, or “community” to more easily depicted terms such as “hammer”, “scale”, or “holding hands”. As part of my Data Murals process I adapted this technique to create collaborative pictographic word webs, helping brainstorm a symbolic language for a data story [2]. The primary learning goals of this activity include understanding when getting off-screen can help in a data project, practicing sketching to develop a visual vocabulary, and collaborating to discover a novel or shared symbology for depicting data.

When meeting in the same place, the activity begins with a large piece of paper with the central word of the story written on it. Each learner brainstorms connected words, in silence, and writes them on the paper, connecting each new word to the word that inspired it with a line. After about 5 minutes we hand out post-it notes and ask the



Fig. 3. A pictographic word web created in person to tease out a symbolic language for “social exclusion” (in Brazilian Portuguese).

participants to look for ideas that are easy to illustrate, draw each one on an individual sticky note, and stick it near the word that it illustrates (see an example in Fig. 3).

Rethinking this activity for a virtual setting, I found some trade-offs needed to be made. In order to keep my learning goal related to collaboration I found myself forced to give up the learning goal related to getting off-screen. I couldn’t come up with a low-friction way to collaboratively sketch on an offline canvas while meeting virtually. I had the Zoom collaboration software at my disposal, so I decided to use the whiteboard feature built in. I found most students familiar with the technology from other classes they were in that had already used it so I expected this would reduce potential technological hiccups. The Zoom whiteboard allows for collaborative writing to happen with real-time synchronization, so each person could see what the other students were writing. Reflecting on the third guiding principle, I tried to imagine ways to use the student’s space as a positive. Some had external large screens, one had a projector, and a handful had tablets with pens or touchscreens. I hypothesized that the tablet format might help, so I asked those who had it to join on their tablets for that session of class. Unfortunately the joy of moving around a large paper, leaning in and stepping back, didn’t feel like it would translate well to this technology. The serendipity of moving around the table lends a lot to this activity, so I was worried about how it would go.

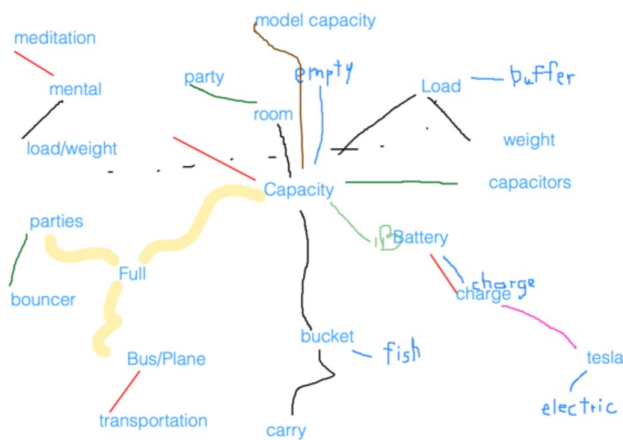


Fig. 4. A collaborative word web created in a Zoom online class using the built-in whiteboard. The central word was “capacity”.

I found that the first phase of word generation worked well, but the sketching process fell flat. The group of students created a word web that I qualitatively assessed to be similar in variety of scope to those made in physical settings (see Fig. 4). However, when we tried to shift into the sketching portion of the activity it fell apart. Students found it hard to sketch with the virtual tools provided, expressing frustration with pixelated drawings “not coming out the way I wanted”, wondering

“where should I draw?”, and laughing at what they had drawn. As those frustrations mounted I decided to end the activity early.

Reflecting on the choices I made, I think I would try this again if I invested more time in investigating and testing other whiteboard technologies. Over the course of the semester I found my students very quick to sign on to a new website and learn how it worked; I have no doubt they would figure out a non-Zoom whiteboard as needed.

In reflection, I attribute this to the affordances of the particular technology I chose - it both supported and hindered the activity. It didn't allow for detailed sketching. That isn't a criticism of the tool so much as a recognition of its intent. Sketching in a virtual environment, even with the goal of stick-figure like cartoon drawings, requires a different UI design and I, as the teacher, shouldn't have assumed Zoom's whiteboard would accommodate both interaction needs. Some criteria I plan to use when selecting a new whiteboard platform for this activity include:

- Can you see other user pens on the virtual canvas? I believe this would help avoid collisions on the whiteboard, helping students not write on top of each other.
- Can you zoom in and out easily? This would assist in making a sketch of a word at high zoom, then zooming out and panning to see the entire web of words and illustrations.
- Do students have tablets available? This makes sketching far simpler than working with a mouse.

In addition, I dismissed the third of my guiding questions too quickly - I didn't turn the student's physical constraints into a positive. Another approach could be to have students draw sketches on sticky notes and post photos to an image board (using Pinterest or some other similar tool). On the whole this activity presented more challenges to being run virtually while still fully addressing my three guiding questions.

5 CONCLUSION

The coronavirus pandemic has upset fall teaching plans, requiring many data visualization learning settings to stay online. Intentionally designing virtual participatory data visualization learning activities requires us as educators to constantly revisit our guiding principles. I have three such principles in this article and discussed how they informed my process - retaining pedagogy and learning goals, carefully considering technological possibilities and limitations, and taking advantage of student's physical constraints. These two examples of translating hands-on participatory data visualization learning activities to be virtual based on those three principles offer useful insights to other activity designers. Public activity guides for both sessions, including early advice for running them online, are attached to this paper as supplemental materials.

ACKNOWLEDGMENTS

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Build a Data Sculpture

Use physical craft materials to tell a data story in 3D

This activity will take 20 to 30 minutes. You should have these materials on hand:

- Local craft materials (plastic bottle tops, wire, fuzzy balls, colored paper, wood blocks, construction paper)
- Tape, glue, scissors
- DO NOT include pens, crayons, or anything else to write with (otherwise people just draw instead of building)
- DO NOT include LEGO bricks (otherwise people just build bar charts)



Going Virtual? Ask participants in advance to gather materials from where they are. This could be craft materials like the list above, or things from their recycling bin, or anything else they have around. This can make it more fun, because everyone is starting with something different!

Background

The idea of playing with data is new to most folks. This activity lets people quickly build sculptures that tell a simple data story with craft materials. The playful approach to the data helps engage the participants in thinking about how stories can be found and presented quickly, and helps people feel more freedom and flexibility about data presentations. It builds a notion of "presentation" instead of "visualization". The activity also builds the ability to translate words and numbers into structural forms. In addition, playing with these materials at the start of a workshop can break down power dynamics that might exist within the group.

Kick off the Activity

Introduce the group to two related "normal" charts of data. One can be a single fact, and the other a medium-sized set of information. If you make your own, be sure to avoid data that the audience knows too well -

we find that leads people to get lost in the nuances and intimate details. We suggest using more generic or high-level data. Here are a few handouts you are welcome to download, print, and use:

- [US Ice Cream Consumption](#)
- [Happiness in the Town of Somerville, MA, USA](#)



Going Virtual? Make sure to post the PDF handouts to the in-session virtual chat, or have just one on-screen via screen-share while people build. Don't email them in advance; this can give curious folks a bit too much time to consider the data.

Ask the group to pair up, preferably with someone they don't know. Show participants a large central table full of the materials you have gathered. Give them 6 minutes to quickly build a physical representation of the data you presented earlier. Don't give them too long, otherwise they will get stuck on nuances instead of just getting their creative juices flowing. Remind them they are creative, and that pipe cleaner bar charts are NOT allowed!



Going Virtual? Have each person build their own sculpture with the materials they have gathered. Put on some background music to make the silent building time less awkward. Make sure to announce when folks have just one minute left.

Have Everyone Share Back

Stop everyone when the time is up. Give each group 1 minute to share what they made. You can summarize by pointing out similarities and differences in the pieces folks made. Often you'll see some people focusing on one data point, while others look at a broader picture. With the happiness data, some people try to merge to two datasets, while others just focus on one. Point out any physical versions of traditional charts to point out how entrenched our current visual presentation techniques are! Try to identify patterns in how the numbers were mapped onto physical objects.



Build a Data Sculpture

Find a Story

Data is most useful when you can use it to tell a story about something. Using the data on this handout, try to find a story that you can tell by building a mini sculpture.

- Does one piece of data jump out at you?
- If you take a step back is there a pattern in the data?
- Do you see a story when comparing one part to another?

Make a Sculpture

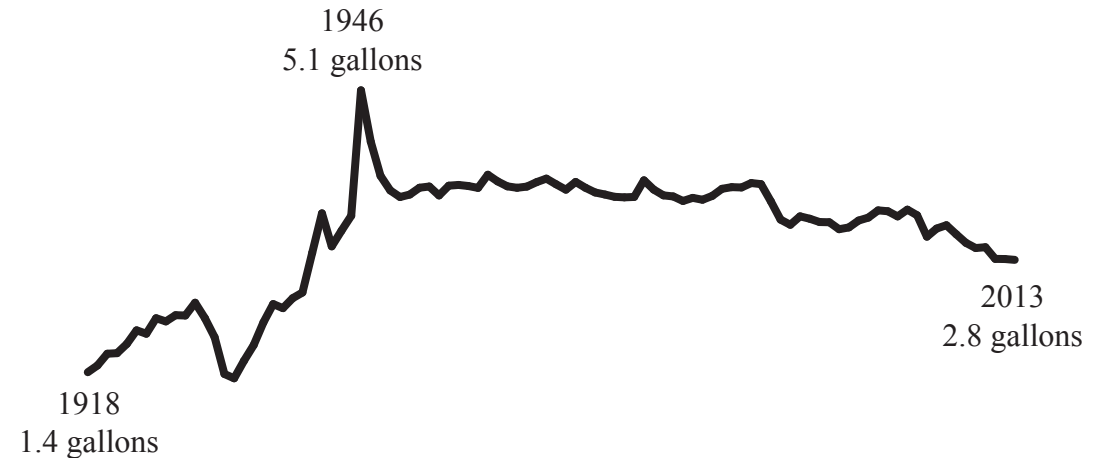
Data visualization is very popular right now, but sometimes is hard to digest. Making a “sculpture” is a fun way to start playing with how to present your data story to other people.

- What symbols can you build to represent your data?
- How can you attract attention with this stuff?
- Can you tell simple and complex stories?

Ice Cream In the US

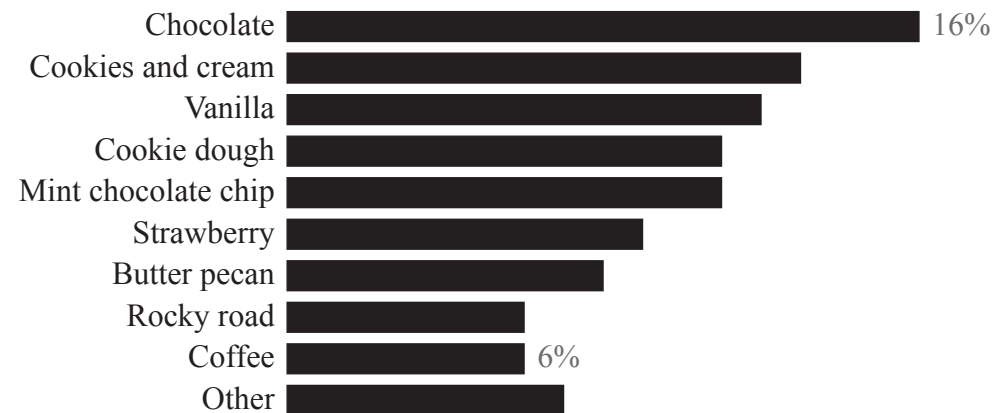
How Much Do We Eat?

This chart shows the gallons of ice cream an average person would eat in a year.



Our Favorite Flavors

This survey asked 1000 people what their favorite flavor of ice cream was in 2014



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How Does Somerville Feel?

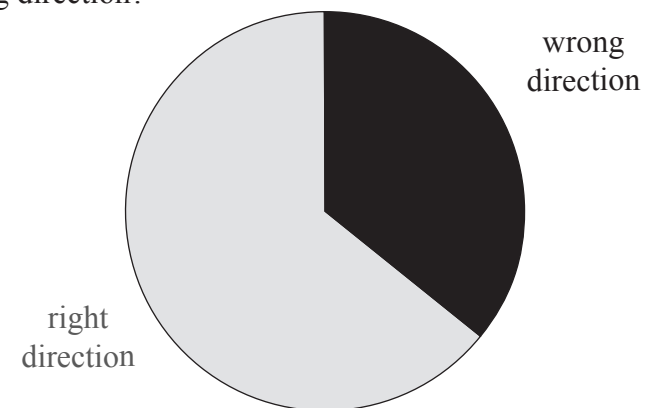
Happiness

Somerville asked its residents “How happy are you right now?”



The Future

Overall, would you say Somerville is moving in the right direction, or the wrong direction?





Sketch a Visual Word Web

Practice translating abstract ideas into concrete images

This activity will take 15 to 20 minutes. You should have these materials on hand:

- Big sheets of paper
- Lots of pens of different colors
- Sticky notes



Going Virtual? Use a virtual whiteboard to run this activity. The Zoom meeting software has it built in, but websites like Miro offer web-based alternatives with more features. If any participants have tablets with pens ask them to use those.

Background

Sometimes your data story is centered around an abstract idea, such as "climate", "injustice", or "rights". Abstract ideas are hard to picture, and even harder to draw. This activity helps you brainstorm more concrete ideas that are related to the abstract concepts. It also helps you come up with visual symbols you could later incorporate into a visual design that tells your data story. Making word webs encourages collaborative teamwork and collective brainstorming.

Kick off the Activity

Begin by spreading out large pieces of paper, each with an abstract concept written in the middle. The concepts should be from a data-driven story you are working with. Words like "poverty", "injustice", and "happiness" are all good examples of abstract concepts that come from data-driven stories.

Give each participant a pen and break them up into groups of 5 or 6, with each group assigned to one of the pieces of paper you just showed. Tell the participants they should start by drawing a line from the central word and writing



another word that they associate with the first one. Keep adding words connected to the first word or to the ones that other people add. Give the groups 6 minutes to brainstorm and write words. Each paper should end up looking like a web of words, connected by lines.



Going Virtual? Write the concept in the middle of your virtual whiteboard in a big font. Show participants how to draw lines, type text, and where the “undo” button is. Consider having them try out writing an idea and drawing a line on a test board before beginning.

Once the time is up, hand out the sticky notes. Give folks another five minutes to identify any words that can easily be sketched out, and then have them draw those on a note and stick it next to the word.

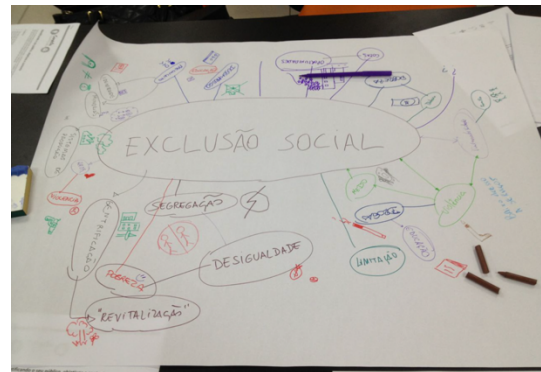


Going Virtual? Consider whether your virtual whiteboard is good for sketching. Drawing with a mouse is hard. You might want to instead have participants sketch their ideas on paper sticky-notes and post them to an artboard website like Pinterest.

Have Everyone Share Back

Bring everyone back together, and have each group hang the sheets of paper on the wall. Give participants a few minutes to walk around looking at what other groups created.

Ask the full group about the connections they saw, the unique or unconventional ideas conveyed, and the pictures that stood out to them as iconic or effective. Highlight any drawings that carry a particular tone, or ones that may only make sense in certain contexts or cultures.



Discuss which pictures are most effective for conveying the concept of the data-driven story you started with.

Note that there are online sources which can help you brainstorm, such as the [Noun Project](#).