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Maker Maps

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INTRODUCTION

This paper introduces an approach to spatial and information literacy instruction that we call "Maker Maps." As a Map and Spatial Data Librarian (Theresa Quill) and a Creative Technologies Librarian (Leanne Nay) at Indiana University, we sought to combine our areas of expertise by using data physicalization and maker literacy to teach spatial literacy concepts. We began this collaboration in part because we enjoy working together, but also to bring some joy and creativity into our teaching. In an age of abundant tutorials for learning GIS software, we were looking for something we could offer students that they couldn't get by asking GenAI to help them learn GIS. We also look for ways to keep our work interesting and engaging, and this approach satisfies both needs.

Maker literacy is the ability to learn, think, and communicate through the hands-on making of physical objects. Rather than focusing solely on technical proficiency, maker literacy focuses on curiosity, iteration, and collaboration. Maker-literate students are able to identify and define problems, select appropriate tools and materials, develop prototypes, and critically reflect on their work. Makerspaces are an ideal location for this type of learning; however, these concepts can also be incorporated into classroom environments. When applied to cartography, maker literacy helps students explore and represent data using physical materials such as paper, fabric, or LEDs.

Data physicalization, defined by Jansen et al. as "a physical artifact whose geometry or material properties encode data" (2015, 3228), is a concept that began in human-factors circles and has been expanded by practitioners of crafting and making (Huron et al. 2022). A common example of a data physicalization is a temperature quilt. These quilts are made of 365 squares, each of which is colored to visually represent a day's high and low temperature. Cartographic data physicalizations continue in this tradition and combine elements of tactile mapping and hand-drawn maps. We have found that hands-on approaches help novice students approach new concepts without the burden of also learning a new software. Roth et al. found that to be true for advanced students as well, remarking that "the sketch mapping activities allowed students to tinker and play with lecture concepts in a low-risk environment using familiar, tangible materials such as pens, markers, graph paper, etc. Without the pressure of data wrangling or learning new software, they were able to be more intentional and reflexive during the design process" (2020, 50).

We have been iterating on data physicalization methods, and present four different projects that can be used in formal class instruction, workshops, or library settings: paper circuit maps, embroidered maps, a globe dress, and collaborative maps using stickers and yarn.

PAPER CIRCUIT MAPS

A paper circuit is a functioning electronic circuit built on a paper surface, rather than a circuit board. Paper circuits are often used in K–12 settings to teach basic concepts of electricity and computing. Using a battery, LED, and conductive tape, paired with a basic understanding of circuits, students can incorporate light into creative projects. Lee and Recker note that "paper circuitry materials are low cost, provide a low threshold to entry, and draw upon the familiarity that already exists with respect to paper as an interactive and manipulable medium," as well as offering "multiple points of entry for students who are less familiar with computational thinking ideas" (2018, 198).

In the spring of 2025, and again in 2026, we partnered with instructor Olga Kalentzidou to lead a paper circuit mapping exercise for students in the undergraduate course *Human Geography in a Changing World*. This general education course hosts students across disciplines, primarily in the arts, humanities, and social sciences. We initially identified paper circuits as a means of comparing analog and digital approaches to mapmaking. Teaching paper circuit maps alongside GIS software such as Felt or ArcGIS encourages students to critically evaluate the strengths and limitations of each method.

Professor Kalentzidou began the activity by asking students to draw a map of Bloomington (where our university is located) on paper. We then guided the students in creating a paper circuit to illuminate specific points on their maps using LED stickers. Students first sketched a circuit template to plan component placement, then applied nylon conductive tape and added the LED stickers. Finally, they inserted a watch battery and secured it with a binder clip to complete the circuit (Figure 1). We provided instructional handouts and circulated around the classroom to offer support as needed.

The primary strengths of this activity lie in its novelty and hands-on, collaborative approach. In a class of nearly forty students, instructors cannot provide individual instruction for everyone, making peer-to-peer learning a natural outcome. We observed that students who quickly and easily constructed their circuit helped their peers troubleshoot. Students from STEM disciplines have likely had exposure to paper circuits (or other electronics), but few students in humanities courses are familiar with the materials, which sparks more interest and curiosity. We also noticed that students put away their laptops and phones, removing a major barrier to instruction. Further, the joy and satisfaction that come from creating light cannot be overstated.

This activity can be expanded or adapted for a variety of classroom contexts. We used **Chibitronics LED stickers** because they are sturdier and easier for beginners to work with than traditional LEDs, which can be delicate and sometimes frustrating for new users. However, they

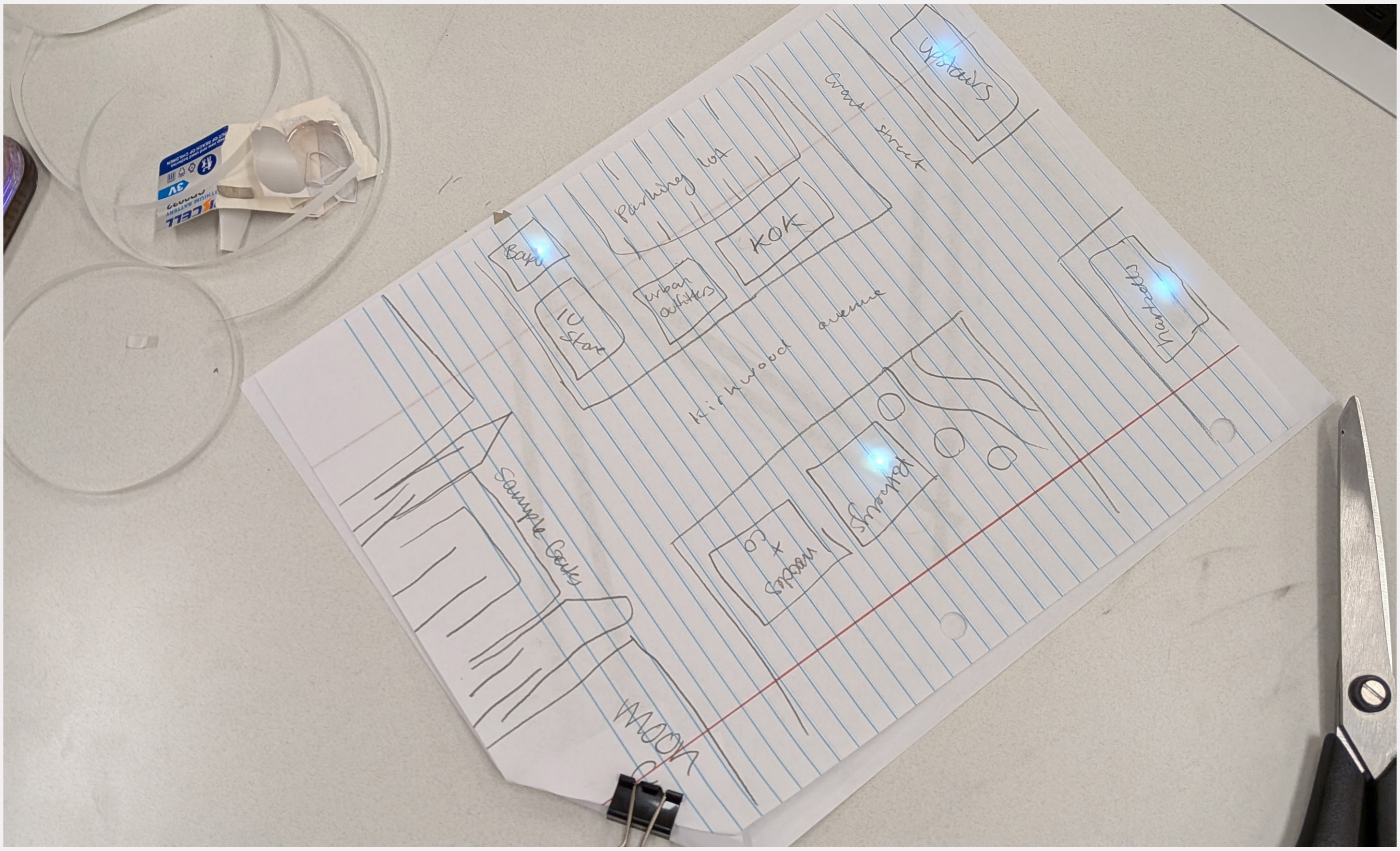

Figure 1. A student's hand-drawn map of the Indiana University campus with specific locations illuminated.

are also significantly more expensive. Companies such as **Adafruit**, **SparkFun**, and **Brown Dog Gadgets** offer paper circuit materials at a range of price points and provide tutorials designed for educators.

For a more advanced version, students could incorporate coding to add greater interactivity to their maps. The **ChibiClip**, which works with Chibitronics LED stickers, includes a browser-based coding platform designed for educational use. With this setup, students could create categories of lights to represent different data layers or use sensors to control when lights turn on and off.

EMBROIDERED MAPS

Our work with embroidered maps echoes the late eighteenth- to early nineteenth-century practice of map samplers in geographic education. In Britain and the United States, women and girls embroidered maps as a way to learn geography while also practicing with needle and thread (Tyner 2015, Eager 2024). Tyner (2015) asserts that this practice marked an opening up of the educational subjects deemed appropriate for women and the growth of geographic education, broadly speaking. Map samplers from this time tended to follow traditional cartographic conventions and included country borders, placenames, and north arrows (Smith 2021, Caughley 2015, Chandler 1835).

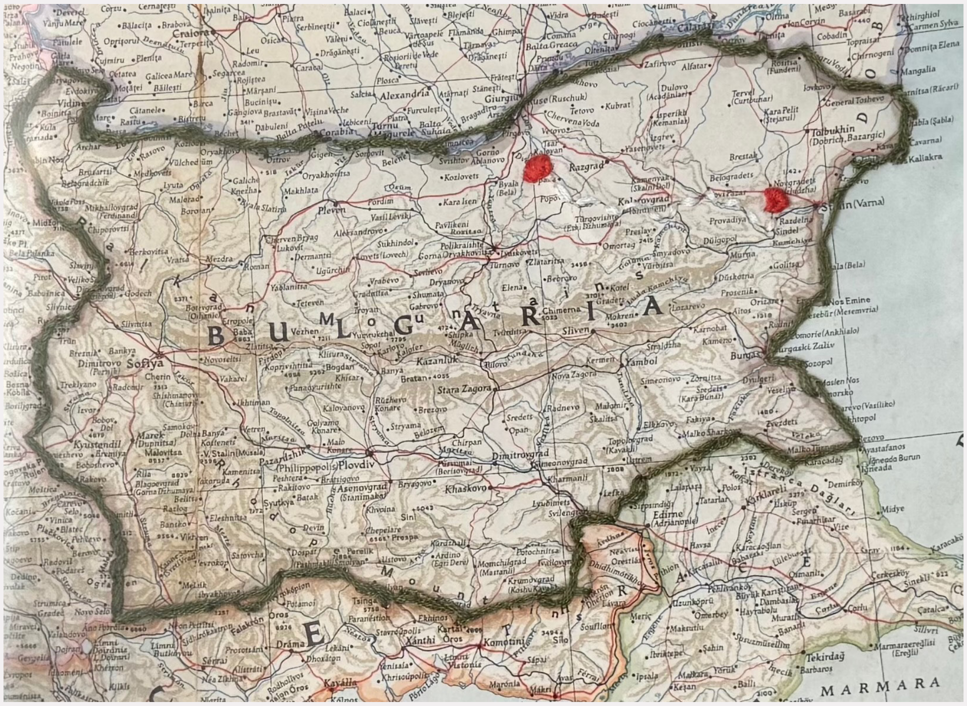

Figure 2. An example from our initial embroidery map workshop, showing the country of Bulgaria outlined, with a path connecting two villages.

Many years ago, we offered a workshop wherein participants stitched over paper maps that had been removed from the library's collection, using embroidery to embellish the maps or trace a path. Participants used a variety of methods—some adding decorative elements, and others using embroidery to create spatial data. In Figure 2, the participant outlined the country border (polygon), added French knots for two villages that were not named on the basemap (points), and threaded a path in white between the two villages (line) to show the frequent journey traversed in a long-distance relationship.

While we had success with the activity as a crafting workshop, it was not until attending a **workshop presented by librarian Meg Miller** at the Western Association of Map Libraries (WAML) 2024 conference that we thought to use this technique as a way to teach about spatial data formats. We then brought it to Theresa's class, *Map and GIS Librarianship*. Students in this graduate-level course had various backgrounds: some were geography students with experience in GIS, while others were library science students with no previous instruction in spatial data. Rather than giving a standard lecture on vector data vs. raster data that would have been repetitive to geography students and dull to library students, we used embroidery to illustrate different data types. Students were given a hoop, fabric, buttons, thread, and needle and asked to create a map that was meaningful to them. Some students chose to map their physical route to the library while others took a more

Figure 3. Embroidered maps created in the *Map and GIS Librarianship* course.

philosophical approach and mapped their "path to librarianship" (Figure 3). We discussed how different elements in their map might be translated to GIS. Buttons or French knots were natural point data, threaded paths became line features, and general areas (sometimes also represented by buttons) became polygons. While we did not use the technique in class, we also discussed how cross stitch is a nice analog to raster data. The physicality of stitching a map helped illustrate these concepts even more than a hand-drawn map with paper and pencil. Students needed to be intentional about their choice of material. Stitching on a button requires more time and thought than drawing a dot with a pencil. Changing colors requires re-threading and knotting a needle rather than picking up a different pencil. By the time traditional GIS software was introduced later in the semester, students had a solid understanding of spatial data formats and basic spatial analysis, and were not trying to learn concepts and software at the same time.

GLOBE DRESS

The "Globe Dress" started as an experimental passion project, and ended up being a lesson in failure. I (Theresa) was initially inspired by the sewist **Sue-Ching Lascelles's** circular caftans. Most "carto couture" is not spatially accurate. Could I create an "accurate" wearable globe? It turns out, as a novice sewist and decidedly *not* an expert in map projections… no, not really. However, failure is a valuable part of the maker process and the globe dress is still a useful pedagogical tool.

It would have been relatively simple to create a **double hemisphere map** on two circular sheets of fabric, sewn together into a dress. That, perhaps, might have been a better idea. Instead, I was thinking about the globe dress as a 3D, spherical object. Our bodies, of course, are not flat. Still, a caftan begins as two flat pieces of fabric. To create the dress, I cut two circular shapes with a 60-inch diameter out of thrifted bed sheets. Next, I pinned the fabric together to determine where the head and arm holes should fall before sewing them together. (Sewing on the curve is challenging! I recommend taking the time to press and pin the folds rather than my method of winging it.) I thought that if I sewed the dress before painting the map I would be able to pull and adjust the fabric into a globe-like shape easier. Next, I used QGIS and Natural Earth data to create a map template. I made a circular layout with a diameter of 58 inches to account for my seam allowance and used a series of custom orthographic projections[1] to simulate a globe. I taped my dress to the wall and used a projector to trace landforms, changing the projection as I moved and folded the dress on the wall. This method proved overly complicated and involved much more "eyeballing" than I had hoped. Perhaps makers with a better grasp on the mathematics of map projections or skill at creating globe gores would have more success. Nevertheless, I created a globe-*like* dress (Figure 4).

I wanted to make a wearable globe, which would naturally show areas accurately. But, this was unattainable for me, and the dress ended up being distorted such that it was larger towards the equator, which made me think about how the "equator" of our bodies is what we often attempt to minimize. How does the distortion of the dress mirror or question how I feel about my body? We envision this "globe dress" as a pedagogical tool that could be used in fashion design or gender studies classes. Some possible discussion questions include:

- How would you project your body onto a 2D surface?
- What would you choose to emphasize or minimize (where is the distortion)?
- What can be left off (are your feet on the map, etc.)?
- What cultural and political norms are influencing those choices in terms of where accuracy is most important?

I plan to conduct further research connecting cartography and fatphobia, and am developing an activity around projected bodies that draws on body liberation literature and feminist geography.

1. You can create a custom orthographic projection in QGIS by going to the **Settings** menu and choosing **Custom Projection**. Input your desired coordinates in place of the brackets in this formula: +proj=ortho =lat_0=[lat] +lon_0=[lon]. For example: +proj=ortho +lat_0=0 +lon_0=-88.5.

Figure 4. A "globe-like" circular caftan with hand-painted landforms.

COLLABORATIVE MAPS

Most recently, we were inspired by a collaborative mapmaking project from Tracy Tien, Johanna Okerlund, and Allegra Dufresne at Wellesley College (Tien et al. 2025). Their project included a map of Massachusetts made from origami-style pyramids, and a multi-layer map with paper pyramids and cross-stitched yarn to explore nighttime lights on the Korean peninsula. They invited their community to contribute to the map using materials and tools from their library makerspace. We used a similar approach and created the structure for two maps of Indiana—a sticker map to visualize the population of cities in Indiana, and a pre-settlement vegetation map made with yarn on a grid. Our materials reflect the nature of the data; yarn is natural and textured and well suited to representing land whereas vinyl is bold and artificial, reinforcing the feel of the built urban environment.

For our sticker population map, we started by creating a choropleth map that showed town boundaries, each color-coded by population into one of five categories, using data based on the Incorporated Areas of Indiana layer, provided by the Indiana Geographic Information Office and hosted on **IndianaMap.org**. We printed the map on our library's plotter printers and cut a sheet of mylar to place on top. Then we used a Silhouette Cameo cutting machine to cut out vinyl stickers, each of which was sized and colored to correspond to the population size. We invited participants to place stickers on the mylar to represent the population across the state. We used mylar rather than placing stickers directly on the map so that viewers could compare the choropleth base map with the graduated symbol stickers, and so we could eventually use the city population sticker layer as an overlay on top of the vegetation map.

Our yarn vegetation map featured a base map made using **data from original nineteenth-century land survey records** and modern soil maps of counties in Indiana. After printing the map, we laid out a series of plastic grids commonly used for fiber art projects on top and traced the outlines in marker. Participants could then select a grid and use an embroidery needle and yarn to follow the outlines.

We kicked off our collaborative mapping project at the Creator Commons Makerspace in our main campus library. We set out the maps and materials on large tables with basic instructions, so that students visiting the makerspace could participate independently. Over the course of a few weeks, several student employees and students contributed to the maps, particularly the sticker map, but we hoped for more engagement. Few students participated without prompting from us or other library staff, so we sought another venue for the project. Fortunately, our local GIS Day was right around the corner. We set up our maps at a social networking event for students and GIS professionals hosted at a local cider company (Figure 5).

Figure 5. Collaborative maps at a GIS Day event.

This was notably a very different audience than the general student population and we also had the opportunity to explain the activities to attendees rather than rely on a handout. Unsurprisingly, we saw much more engagement and discussion at GIS Day. If we were to repeat this project, we would seek a partnership with an instructor to ground the activities within a course and encourage more active participation and reflection while still reaching a general student audience. Now that the maps are nearly complete, we plan to display them near the map collections in our main library.

CONCLUSION

These four projects illustrate our approach of using physical materials and a maker mindset to teach core spatial literacy skills. We have anecdotal evidence that this approach interests students and allows them to engage with concepts without the complication of software, which can be particularly useful for introducing spatial literacy in disciplines that do not traditionally employ formal spatial analysis. Future plans for this work include conducting a formal assessment study and continuing to refine and expand methods that integrate craft-based making with mapping.

REFERENCES

Caughley, Vivien. 2015. "Cook Map Samplers: Women's Endeavours." *Records of the Auckland Museum* 50: 1–13. **http://www.jstor.org/stable/90014732**.

Chandler, Elizabeth. 1835. *Embroidered Map Sampler*. Silk Embroidery on Wool. *The Metropolitan Museum of Art*. **https://www.metmuseum.org/art/collection/search/226539**.

Eager, Elizabeth. 2024. "Sewn in Place: Gender, Materiality, and Mapmaking in the Early United States." *The Art Bulletin* 106 (1): 40–69. **https://doi.org/10.1080/00043079.2024.2279448**.

Huron, Samuel, Till Nagel, Lora Oehlberg, and Wesley Willett, eds. 2022. *Making with Data: Physical Design and Craft in a Data-Driven World*. First edition. Boca Raton, FL: CRC Press. **https://doi.org/10.1201/9781003264903**.

Jansen, Yvonne, Pierre Dragicevic, Petra Isenberg, et al. 2015. "Opportunities and Challenges for Data Physicalization." In *CHI '15: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, 3227–36. New York, NY: ACM. **https://doi.org/10.1145/2702123.2702180**.

Lee, Victor R., and Mimi Recker. 2018. "Paper Circuits: A Tangible, Low Threshold, Low Cost Entry to Computational Thinking." *TechTrends* 62: 197–203. **https://doi.org/10.1007/s11528-017-0248-3**.

Roth, Robert E., Chelsea Nestel, Tanya Buckingham Andersen, et al. 2020. "Madison and Vicinity: A Tangible Map Quilt." *Cartographic Perspectives* 95: 50–56. **https://doi.org/10.14714/CP95.1615**.

Smith, Cynthia. 2021. "An Embroidered Map of England and Wales." *Personal Voices from the Library of Congress*. June 30, 2021. **https://blogs.loc.gov/maps/2021/06/an-embroidered-map-of-england-and-wales**.

Tien, Tracy, Johanna Okerlund, and Allegra Dufresne. 2025. "Map Making: Fostering GIS and Makerspace Inquiry through a Collaborative Data Physicalization Project at a Liberal Arts College." *Big Ten Academic Alliance*. Presented at the 5th Big Ten GIS Conference, April 11. YouTube video, 16:08, April 21, 2025, **https://www.youtube.com/watch?v=5NO5pDTXiKk**.

Tyner, Judith A. 2015. *Stitching the World: Embroidered Maps and Women's Geographical Education*. Farnham, UK: Ashgate. **https://doi.org/10.4324/9781315242378**.