Lessons from the Pumpkin Patch: Building Community and Visualization Literacy with Physical Visualization

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Figure 1: *Finished pumpkin patch project lit up at night for student viewing. Pumpkins are carved to represent each residence hall on campus, with individual features (windows, doorways, staircases, carved edge pattern, etc.) encoding specific data attributes about each building.*

Abstract

Teaching introductory visualization classes is a challenging job. These courses often attract students with wide range of prior preparation, and many arrive without formal training in the foundations of computing or statistics. Further, educators face the challenge of growing and adapting in response to new best practices for inclusive and accessible computational education. In this paper, we present a case study documenting a class-wide physical visualization project designed to foster a classroom learning community, reinforce the principle of data-visual mapping, and engage students in a creative and community-focused data project. Guided by inclusive pedagogy and learning science principles of scaffolding, constructivism, and constructionism, the project challenged students to create a physical visualization out of carved pumpkins that would engage the campus community. Student responses to the project were overall extremely positive. An evaluation of the project showed students walked away with increased respect for large-scale projects, a deeper understanding of data-visual mapping, pride and awe in their creation, an increased sense of classroom and campus community, and appreciation for the accessibility of the project.

A free copy of this paper and all supplemental materials are available at: `https://github.com/amosca01/pumpkin-patch-proj-materials`.

CCS Concepts
• Human-centered computing → Visualization; • Applied computing → Collaborative learning;

1. Introduction

Teaching introductory visualization classes is a challenging job. Generally taught as an elective rather than as part of a core curriculum, these courses often attract students from across the spectrum of class years and majors. Students come to the classroom with a correspondingly wide range of prior preparation, and many arrive without formal training in the foundations of computing or statistics. In the absence of a standardized curriculum agreed upon by experts, most instructors must independently develop learning goals specific to their group of learners, institution, or background [BKR*24]. Compounding these issues, educators also face the challenge of overcoming the historical inaccessibility of computing classes.

Fortunately, many of the principles of inclusive computational pedagogy lend themselves to scaffolding a class with diverse skill sets and learners. Vygotsky's Zone of Proximal Development (ZPD) [C*03] highlights the critical role of support, or *scaffolding*, in enabling learners to bridge the gap between their current abilities and their potential capabilities. Inclusive computational pedagogy centers this dynamic interplay between assistance and independence, focusing on collaborative and community-based learning, highlighting the benefits of diverse perspectives, and encouraging creativity [Ros23, hoo94]. These same ideas also echo in discussions of Piaget's *constructivism*, which further emphasize that learning is most effective when it is active, self-directed, and deeply connected to the individual experiences of the learner [Ack01].

Seymour Papert's *constructionism* offers a practical perspective on these themes, arguing that Piaget's constructivist goals are best achieved in the meaningful construction of and engagement with physical artifacts [Pap93]. Papert's theory underscores the importance of providing accessible entry points ("low floors") while offering ample room for creativity and complexity ("high ceilings") in educational contexts. This open-ended approach encourages students to take ownership of their learning and to engage in collaborative iteration on their designs, thereby deepening their understanding of data visualization through shared inquiry and dialogue.

The Case for Collaborative Physicalization

In this paper, we present a case study of a physical visualization project designed to invite playful creativity and to foster community both inside and beyond the classroom, while reinforcing the core visualization principles of data-visual mapping. Physical visualization was chosen as the medium because it is well documented as an accessible means of teaching visualization to learners without computational backgrounds [HJC14, BD17], and has also been shown to encourage creativity [RBB*22]. Students were tasked with creating a physical visualization out of carved pumpkins that would engage the campus community, and were given complete creative control over the data, the design, and the organization of their own effort. Students were free to choose any data they felt would be compelling to the campus community, building on prior findings that experiences with personal data can increase student creativity [Per21]. To motivate community engagement, students were encouraged to design with Georgia Lupi's principles of data humanism in mind [Lup17].

This paper makes the following contributions to the ongoing conversation about pedagogical innovation in data visualization:

1. a discussion of the **motivation** of the project and its intended learning outcomes,
2. a **project timeline and complete instructional materials** to facilitate replication,
3. a **case study and lessons learned** from implementation of this project in the context of a small liberal arts college (SLAC),
4. a set of recommended starting points for **adapting the project** to different academic environments.

2. Related Work

Though visualization research and application have made great strides, best practices for *teaching* visualization remains an open area. In 2024, 21 visualization educators and researchers came together to explore challenges and opportunities in visualization education. They identified 43 research questions inspired by these challenges in addition to five opportunity areas crosscutting all challenges. In particular, they urge: "embrace DIVERSITY AND INCLUSION" [BKR*24], mirroring a larger call to action among computer science educators to re-imagine curriculum and pedagogy to center the experiences of minoritized students.

In that vein, Rosenbloom recently presented an abolitionist framework for computer science education [Ros23]. In it she highlights how abolitionist pedagogy teaches re-imagining education as a community practice based in respect, well-being, and joy as critical step in undoing structural harms of educational systems [hoo94, hoo90, JAM21, Lov19, SDL18]. Visualization education lends itself exceptionally well to these practices as interdisciplinary teams have been shown to help students navigate the interdisciplinary nature of visualization and end up with better end products [EE12]. Moreover, in an abolitionist framework creativity is vital; encouraging students to imagine how the skills they are learning can be used for progress and community care as opposed to sustaining the status quo is a cornerstone [Ros23].

However, designing a group project where all students feel they have something worthwhile to contribute can be a challenge in computation-heavy courses. One way to circumvent this is to introduce projects that ask students to create physical, as opposed to digital, visualizations. For example, Huron et al. demonstrate the efficacy of tangible tiles to teach data visualization to novices [HJC14], and Bhargava and D'Ignazio successfully used several low-tech, activity-based data structure workshops to introduce novices ranging from elementary school students to working professionals to data visualization [BD17].

In addition, building a physical visualization has been shown to strengthen learners' grasp of visualization principles. Roberts et al. stress the usefulness of non-computational tools, explaining that this approach leads learners to focus more explicitly on visualization principles as opposed to implementation [RBB*22]. Similarly, Huron et al. introduce the paradigm of constructive visualization as a means of increasing accessibility of information visualization [HCT*14] postulating that constructive visualization strengthens understanding of the relationship between visual variables and the data underlying them.

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3. Case Study: The Pumpkin Patch Project

The pumpkin patch project presented in this paper seeks to answer these calls by leveraging the advantages of physical visualization in a community-and creativity-focused setting. By scoping a project through these lenses, the authors hoped to create an accessible project that would facilitate community, encourage creativity, and reinforce data visualization principles. In that vein, the specific learning objectives of the project were:

1. Design and build a physical data visualization with appropriate data-visual mappings,
2. Work collaboratively with a large group to complete a multi-stage, sizable project,
3. Engage the Smith community with the final display.

The project took place roughly half-way through the semester. At that point marks and channels, data-visual mapping, basic charts, perception, color, and storytelling had been covered in class and practiced in homework assignments. One lecture before the project was introduced students learned about Giorgia Lupi's concept of Data Humanism [Lup17] and explored her prior work. Data Humanism was then used as a jumping point for students when the project started.

In total, the project lasted two and a half weeks. The majority of the work was carried out during class time (5 seventy-five minute class periods were dedicated to the project), but students were also asked to contribute time outside of class. Full project instructions are available as supplemental material (`mid-sem-proj.pdf`).

3.1. Phase 1: Ideation and Organization

Day 1: To introduce the main ideas behind the project, students were given the following prompt:

For this midsemester project you will work together as a class to create a physical data visualization designed with the tenants of Data Humanism in mind. We will share the physical visualization with the campus community on Project Release Day (see course schedule).

Because the physical visualization will be displayed on Halloween, the medium we will work with to create the physical visualization will be carved pumpkins.

Break into groups of 5. With your group generate one, specific idea for a physical visualization that will engage the campus community. Consider the following guiding questions:

1. *What do you want the impact of the visualization to be?*
2. *What data would you need?*
3. *What visual encoding would you use?*
4. *How will the campus community engage with the visualization?*

Keep in mind the ideas of Data Humanism—embrace complexity, move beyond standards, sneak context in, and remember data is imperfect. In addition, think about how you will cater your visualization to engage the community:

1. *Will it be interactive?*
2. *Will the data be specific to people at Smith (or a certain subset of them)?*
3. *Will folks viewing the visualization learn something new?*
4. *Would you want them to leave with a specific feeling?*

Students spent class time brainstorming ideas for the final visualization. They were told to be prepared to pitch their project idea to their classmates during the next class period. The project prompt was intentionally left broad to encourage creativity and multiple interpretations of how one could make an engaging and interactive physical visualization.

Project Roles

To help the class function cohesively and to make sure all students were involved, on day one students were asked to sign up for a specific role to take on for the duration of the project:

- **Visual Encoding Leads** were responsible for all aspects of the visual encoding
- **Data Collection Leads** managed the data collection process
- **Data Cleaning Leads** preprocessed the collected data
- **Visualization Stencil Leads** designed and produced the stencils that would be used in the carving process
- **Visualization Set-up Leads / Extra Hands** designed and executed the public display
- **Visualization Q&A** team members were available to answer questions from the public about the project
- **Advertising Team Leads** were responsible for notifying the campus community about the project
- **Visualization Clean-up Leads / Extra Hands** took care of breaking down the display at the conclusion of the exhibition.

Any role titled "lead" included a leadership aspect such as leading the class through finalizing the visual encoding design for the pumpkins, or organizing how the class would work together to collect the nescessary data. Full role descriptions are available in supplemental material.

3.2. Phase 2: Design Finalization and Data Collection

Day 2: Each brainstorming group got in front of the class and pitched their project idea to their classmates. After all pitches were heard, students voted for which they wanted to pursue. The class voted via a Google Form. After a topic was chosen, the Visual Encoding Leads began guiding the class through a discussion refining and finalizing the visual encoding design.

Day 3: After refining the design on their own time, the Visual Encoding leads presented the class with their final idea. The class worked together to tweak the idea such that it would be more attainable in the time allotted. The professor provided input to steer students in a good direction, but otherwise did not guide this discussion. The remainder of class was run by the Data Collection Leads, who assigned small groups of students to different data collection tasks to amass the necessary dataset. Simultaneously to visual encoding finalization and data collection, the Advertising Team Leads and a set of volunteers created advertisements and a distribution plan to advertise the final pumpkin display to the campus community. Outside of class the Data Cleaning Leads met to clean and finalize the collected data.

3.3. Phase 3: Creation

The final week of the project consisted of the actual pumpkin carving and display. On **Day 4**, Visualization Stencil Leads and a set of volunteers created stencils for students to follow when carving pumpkins. Meanwhile, the remainder of class worked together to gut all 41 pumpkins required for the final display.

On **Day 5**, students carved pumpkins during class time. After class the Visualization Set-up leads and volunteers finished remaining carving and set up the final display. Later, the Visualization Q&A team stationed themselves by the display to answer questions as the campus community came through and interacted with it. The Q&A team were active from 4-6pm, but the display was left up overnight for the campus community to enjoy.

3.4. Finished Display

The final product of the project was a display of pumpkins representing all houses on Smith College's campus plus one pumpkin for commuters (Figures 1, 2, top). Each pumpkin represented one house, and the features on the pumpkin were carved to provide information about the house it represented. For example, the cut on top of a pumpkin represents whether or not the house it represents is affinity housing. The number of window panes (created with ribbon and push pins) represents in which half decade the oldest part of the house was built. If shutters are carved on the pumpkin, the house has a porch swing (Figure 2, lower left).

To make the display interactive, students invited viewers to find their house and add a clothes pin to it to represent the sense of belonging they feel in their house community. Students could add a green clothespin to represent feeling a sense of belonging, a tan if they felt neutrally, or a red one if they did not feel a sense of belonging. The full data-visual mapping key is available in supplemental material.

4. Evaluation

In line with the pedagogical principles of ZPD [C*03], inclusivity [Ros23, hoo94], constructivism [Ack01], and constructionism [Pap93] students were assessed via written self-reflections, a form of ungrading. Pedagogical research on introductory computing and data science has shown ungrading improves students' intrinsic motivation to learn, creates more equitable classroom environments, and enhances student collaboration [Smi24, The23]. Following these principles and the project learning objectives, students were required to reflect on the following:

1. What were your specific contributions to this group project?
2. If you were to do this project again, what would you do differently?
3. What is your primary takeaway from completing this project?

In addition, students were invited to provide feedback on the project so that it could be improved in future semesters. Feedback prompts included:

1. What in your opinion were the benefits and drawbacks of doing a project that involved the entire class?
2. Do you think making a physical visualization, as opposed to a computer based one, impacted your learning? If so, how?
3. Please describe your general experience completing this project.

To assess the project as a whole, one author analyzed student reflections and feedback. Responses were grouped by similarity until themes emerged. Each emergent theme is discussed in detail below.

4.1. Results

Student responses to the project were overwhelmingly positive. Multiple students expressed surprise that it was possible to complete a project working together as a class, and pride in the scale of the final product. Others noted that physically carving representations of data into pumpkins helped them internalize the connection between data and visuals. Students found the project to be inclusive of everyone in the class, regardless of background, and were grateful for an experience that brought them together as a class. The following subsections include details and direct quotations organized around key themes that emerged in the analysis of student feedback.

4.1.1. Respect for Large-scale Projects

Out of 32 students, 15 noted at some point in their reflection and feedback that working on a project involving the entire class was impactful and a significant takeaway from the assignment. Many noted surprise that a project could be completed with such a large group. Students reported that a class-wide project taught them the value of teamwork and shared responsibility for a product, and that it developed skills for working in a large team, such as dividing labor effectively, and communicating clearly. Students also expressed appreciation for the focus on collaboration and mutual support:

> *"Additionally, this project strengthened the value of teamwork and adaptability. Collaborating with my classmates and managing tasks, especially during the carving and setup phases, taught me the importance of clear communication and shared responsibility."*

> *"Another big takeaway is how important teamwork is. This was the first time I'd worked on a project involving the entire class, and it felt great to be part of something where we all had each other's backs. Additionally, I also learned the importance of clear, detailed instructions, especially when working with a team on complex tasks."*

Overall, the drawbacks students listed were not surprising, nor did they deviate substantially from the drawbacks common to any group project. Nine students raised concerns that all classmates did not contribute to the project equally, which they felt resulted in unfairness. One student said the project taught them a lot about collaboration, but not more about visualization.

The fact that so many students noted working in a large group as an impactful part of their learning experience indicates that learning objective 2 – *Work collaboratively with a large group to complete a multi- stage, sizable project* – was successfully met. In addition, students responses indicate that the project structure did encourage collaborative work, as intended.

Figure 2: ***Top.*** *Final display of pumpkins representing all houses on campus.* ***Bottom left.*** *An example pumpkin representing an affinity house (jagged top cut) first built after 2010 (7 window panes), with a brick exterior (rectangular door), no porch swing (no shutters), and no elevator (stairs).* ***Bottom right.*** *The view from the back shows the number of residents (holes) in the house arranged according to class year.*

4.1.2. Deeper Understanding of Data Visualization

Twenty-two students answered the optional question: "Do you think making a physical visualization, as opposed to a computer based one, impacted your learning?" All but one believed that making a physical visualization was an important aspect of this project, and most explained that physical visualization gave them a more expansive understanding of visualization and data:

> *"My primary takeaway is the realization that there are many ways to visually encode data."*

> *"My prime takeaway from this project was being able to interact with data and data visualizations in a new away that I had not been able to before, and expanding my scope about data visualizations."*

For some students, physically representing data allowed them to connect with it in a way they had not experienced before:

> *"I also feel that I gained a more nuanced understanding of data humanism. It's one thing to read about a project and imagine concepts, but actually going through the steps and collaborating with my peers reinforced my learning. I gained a new way to conceptualize data, and an increased enthusiasm for the field of data science!"*

> *"For the first time, I felt like I fully understood the data I was working with. The process was engaging and made me feel more connected to the project. Creating a physical representation of the data brought it to life in a way that computer-based visualizations never had for me."*

> *"The hands-on aspect helped me understand how each individual data point can hold meaning, as I personally carved each data point myself."*

For others, a physical visualization reinforced the principle of data-visual mapping in a tangible way:

> *"At the start, I didn't have the full picture of how our project would come together, especially since we were conveying our data by carving pumpkins. However, after the second day of carving and seeing how the shades, windows, and shapes of the doors represented different characteristics of the houses, it all made sense."*

Some students even noted a deeper understanding of the nuance of visualization design:

> *"My primary takeaway from this project is that following the guidelines of data visualization is necessary at times, but isn't necessary all of the time, especially in physical visualizations. It's important to step out of the binary of the guidelines as nothing is ever right all of the time."*

Collectively, these responses show the principles of constructivism and constructionism [Ack01, Pap93] in action through the project. In building a *physical* visualization students were able to gain a tangible, deep, and nuanced understanding of data-visual mapping. Further, student responses indicate that learning outcome 1 – *Design and build a physical data visualization with appropriate data-visual mappings* – was achieved.

4.1.3. Pride and Awe

Throughout the project it was clear that student buy-in was high. All students participated and were invested in the outcome of the project. About twenty percent of the class noted in their reflections pride in the scale of the project and how well the class came together as a whole to accomplish it:

> *"When I first saw this project, I doubted the idea of the whole class working on a midsemester project together, especially carving pumpkins, could we even finish? However, this group project gave me a completely different experience. In the end, everyone worked so well, and I'm proud of our whole class. This is a huge project."*

> *"I mostly spend time in humanities and that is a very individual centered style of learning. Group projects with a whole class made it feel like a light lift from everyone, because all of us were lifting. I was honestly shocked by how fun it was and how much we were able to accomplish. I don't think I've ever really experienced that in my personal or professional life."*

Others explained that the project felt meaningful and impactful:

> *"I would say the results are astonishing. A project involving the whole class, with everyone contributing effort, creates results that can't be compared to a small group project."*

> *"Although I'e (sic) taken many data science classes, this project felt the most meaningful."*

> *"Carving and setting up was tiring, but seeing the final results and how people were amazed by our project made a big impact on me."*

As the principles of constructivism and constructionism [Ack01, Pap93] predict, students felt deeply connected to and invested in the project, and by extension their learning. The sense of ownership and pride students took in their work was a stark difference from the typical fixation on grades and points.

4.1.4. Sense of Community

Two goals of the project were building community among classmates, and challenging the class to think about engaging the campus-wide community with their work. Reflections and feedback highlighted that both of these goals were met. Seven students explicitly noted that a project involving the entire class created a sense of community. Students remarked on the high engagement level and dedication of their peers:

> *"Working on this project with the entire class created a sense of unity and collaboration. It felt like we were all supporting each other, with no competition, which made the experience warm and enjoyable. I had the chance to meet and talk to new people, building connections that I might not have made otherwise. It was interesting and rewarding to work together as a whole class."*

> *"The project fostered a strong sense of team spirit and community among the class. Unlike many group projects where work is often divided unequally, I observed that everyone was equally involved and dedicated to promoting the project. This collective effort made the experience much more cohesive and engaging."*

"Literally the best. It made me get closer with students I sit far away from, helped me apply data humanist concepts to real life, and helped me feel apart of the Smith community."

Nine students wrote that a primary takeaway from the project was an understanding of visualization as a means of creating community. They noted how the final display was able to engage the campus community and bring them together:

"I learned the importance of creating data displays that people can enjoy and engage with. It was rewarding to see how much people appreciated the pumpkin display, especially around Halloween. This experience showed me that while accuracy and consistency are valuable in data collection, sometimes the process and enjoyment of creating a data representation can be just as meaningful. The focus does not always have to be on precision; it can also be about engaging others and celebrating the data journey."

"The biggest thing I learned from this project is that representing data in a more human, creative way can bring people together. This project showed me that data humanism really does unite people. Working on the pumpkins helped us all connect, not just within the team but with everyone who stopped to admire the display. It was interesting to see people pause, take a closer look, and talk about the houses. If we'd just put that data on a printed graph, I doubt it would have had the same impact. The carved pumpkins showed that data doesn't have to be dry or purely numerical and that it can tell a story and create an emotional connection when presented in an unexpected way."

"My main takeaway from this project is how working together can bring data to life in a way that feels personal and connected. Collaborating with classmates to represent Smith creatively through pumpkin carving made it feel like more than just a class project; it became a fun reflection of the Smith community."

"One of the most rewarding aspects was seeing the final visualization come together on campus and how the Smith community interacted with it. It was delightful to know that our work was not only visually compelling but also meaningful."

Student feedback clearly shows that learning objective 3 – *Engage the Smith community with the final display* – was met. As pedagogical work by Rosenbloom [Ros23] and hooks [hoo94] suggests, a collaborative and community-focused project led students to build rapport, collegiality, and community with their classmates. Additionally, that sense of community extended beyond the class as the final display successfully drew in dozens of students outside of the class.

4.1.5. Accessibility

Student sentiments on a physical visualization echoed those of prior work. Many students expressed that the shift to a physical visualization leveled the playing field between students with and without coding experience and helped them re-engage with the material:

"Yes, it was very hands-on and interactive, and I didn't feel left out or anxious about my coding skills or my ability to contribute. Making a physical visualization allowed me to participate confidently and engage with data in a way that was inclusive and accessible to everyone, regardless of their coding experience."

Others explicitly mentioned benefits in moving away from digital visualization, such as more opportunity for creativity, and reinvigoration for the subject matter:

"I much preferred making a physical visualization. As someone who still does not have such a good grasp on Tableau, I found the physical visualization much more conducive for creativity. It was it much easier and interesting to understand, conceptualize and plan out the physical visualization (versus experimenting and not sure what the outcome will be)."

"I think this is a great idea for the class because Tableau and I are not besties, and I've been getting frustrated with it, and this sparked a love and passion for me to get back on the horse again and finish the semester strong."

In particular, the focus on data humanism and a physical visualization appealed to students coming from humanity backgrounds:

"I think data humanism appealed to me as an anthropology major because it feels like it's trying to incorporate the complexity of the human experience in a seemingly impersonal science, and I think that's really cool. This project allowed me to really understand how the process of taking information and turning it into a creative, messy visualization works."

The focus on accessibility and inclusivity of the project in student feedback highlights the benefits of approaching learning through the lens of ZPD [C*03]. By taking the more technical aspects of building a visualization out of the project, students were able to focus explicitly on understanding and using the theoretical principles underpinning data visualization. In contrast, when asked to build digital visualizations students tend to get caught up in the technical details of implementation and forget about theory, particularly those who are new to computer science and data science.

5. Discussion

The overarching goals of this project were to foster a classroom learning community, reinforce the principle of data-visual mapping, and engage students in a creative and community-focused data project. Student feedback indicates the the project was successful at meeting these objectives. Several additional positive outcomes were noted by instructors:

Engaging the Campus Community: Students were encouraged to design a physical visualization that would engage the campus community. The extent to which students achieved this goal was surprising to them as well as faculty. Due to convenient timing, the final display took place on October 31, Halloween in the US. The display was officially open from 4pm to 6pm, but was left up for the night. From 4–6pm, many students stopped by and engaged with the display. At any given time anywhere from 2 - 10 students were present, looking for their houses. Interestingly, multiple students and faculty noted that they stopped by the display later in the night and there continued to be a steady stream of students interacting with the display. Clearly, the experience was meaningful and interesting to students well beyond those in the class. The following semester, registration numbers for the class were exceptionally high. Its possible that the pumpkin display contributed to this, as it drew in students from all over campus.

Sharing of a Tradition: Pumpkin carving is a popular activity in the US to celebrate Halloween. A surprising outcome to the class instructor was the excitement students who grew up celebrating Halloween in the US had to share the tradition of carving pumpkins with students who had never done so. Several students noted in their feedback that it was meaningful and special to them to teach their classmates about the tradition of pumpkin carving. Moreover, students who were new to pumpkin carving were excited for the opportunity to learn. Many wrote in their feedback that they were proud of learning to carve, and multiple brought friends to the final display to show them the pumpkin they had carved. These reactions indicate that the community built between classmates ran deeper than working towards a mutual goal, students also became invested in each other on a more personal level. The benefits of this investment were evident in the classroom after the project concluded. Students were more likely to speak up in class and work together on group activities with little prompting.

Joy: Learning can be a frustrating activity. It requires moving outside one's comfort zone and interacting with unfamiliar material. And particularly in computer science, learning often requires some element of failure in order to progress. These realities coupled with additional factors, often leave students feeling anxious, stressed, and unwilling to take chances. One of the biggest "wins" of this project was that it pushed students to joyfully engage with new material. Excitement about the project was evident during each class session. Students were engaged but also laughing, smiling, and joking. The vast majority of students reported having fun doing this project, and cited it as one of their most positive learning experiences to date. As an instructor, seeing students less burdened by anxiety and stress and still deeply learning new material was extremely rewarding. Moreover, after the COVID-19 pandemic and during the divisiveness of the 2024 US presidential election, it is essential to focus on education as a collaborative, community-oriented space.

6. Limitations

Though this project achieved multiple learning goals and was overall successful in the implementation described here, there are limitations. One limitation is class size. The class that participated in the project was 32 students, and the project setup would not necessarily scale well to substantially larger class sizes. For example, more voices would need to be heard during brainstorming, project roles would need to be expanded in some creative way, and cost could become prohibitive. However, with modifications, a similar project could absolutely be completed with a larger class.

One way to complete a similar project with a larger class (given sufficient resources), would be to split the class into groups of roughly 30 and have multiple physical visualizations at the end of it. To ensure the project still builds community among the entire class, peer review elements could be added. For example, after groups A and B decide on visual encodings they explain their idea to the other group, which provides constructive feedback. In addition, the end of the project could involve a debrief day where members of group A point out aspects of group B's final product that they admired and vice versa.

To reduce cost, a less expensive medium could be used to construct the visualization. For example, students could be challenged to design a visualization drawn with chalk on campus sidewalks, or a visualization made from materials they collect from lost and found boxes or surrounding nature.

An additional limitation of this project is the amount of time it requires. For this particular iteration five 75-minute class blocks were reserved for project work. To accomplish this, five class blocks of other material had to be dropped. The instructor of this course chose to remove several advanced topics (introduction to visual analytics, evaluation, and network visualization) from the class syllabus to make time for this project. The rationale behind this choice was that these more advanced topics were not required for students to successfully complete their final projects for the class, and are covered in depth in a higher-level visualization class offered at the school. Moreover, students cannot engage fully with these topics without a solid grasp on the principle of data-visual encoding.

7. Conclusion

Guided by inclusive pedagogy and learning science principles of scaffolding, constructivism, and constructionism, the pumpkin patch project was designed to (1) foster a classroom learning community, (2) reinforce the principle of data-visual mapping, and (3) engage students in a creative and community-focused data project. By asking students to work together as a class with unfamiliar material to create a an engaging and community centered physical visualization, these goals were largely met. Student feedback highlighted the value of physically representing data with marks they carved into pumpkins themselves, explaining that the physicality of the activity allowed them to grasp the concept of data-visual mapping in a more concrete way. Most students described the project as inclusive, and credited the it with building a sense of community among them. Students involved in the project as well as faculty noted the way in which it brought together the campus community, attracting dozens of student observers well into the night.

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