

A Collective Reflection on Surface and Substance in Visualization Teaching and Learning

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ABSTRACT

Visualization pedagogy often asks students to make choices that extend beyond representation alone. Yet as visualization educators, we have repeatedly encountered moments in our own teaching where the relationship between a visualization’s outward form and what shapes its production remains implicit. In such moments, students may learn to reproduce conventions without fully engaging with the assumptions and values that gave rise to them. We describe this relationship as one between **surface** (what a visualization looks like and appears to claim) and **substance** (the processes, values, and commitments that produced it). Drawing on collaborative reflective inquiry, we present eight situated, first-person reflections on moments from our own teaching where surface and substance came into question. Reading across these cases, we also present four tensions concerning intentionality, interpretation, pedagogical structure, and misalignment. Rather than resolving these tensions, we seek to trouble our teaching practices and examine the relative ease of surface over substance woven into how we teach, from the tools and examples we bring into the classroom to how we structure and evaluate student work. We conclude with reflective probes to help educators examine these tensions within their own teaching, and open a wider discussion within the community.

Index Terms: Visualization education, Critical visualization, Reflective practice, Collaborative inquiry, Design pedagogy.

1 INTRODUCTION

Learning visualization involves more than mapping data to visual forms. Across classroom assignments, storytelling exercises, visualization workshops, and collaborative design activities, learners are routinely asked to interpret data, communicate meaning, and justify visual design decisions [3]. Yet, the relationship between a visualization’s outward form and what shapes its production is not always made explicit within teaching and learning contexts. As a result, students may learn to reproduce the visual conventions associated with particular approaches [20] without fully engaging with the assumptions, values, or methodological orientations that gave rise to them [26, 33].

We name this relationship as one between **surface** and **substance**. The **surface** of a visualization is its visually apparent layer: its form, aesthetic choices, and representational conventions (i.e.,

what it looks like and what it appears to claim). By **substance**, we mean the processes, assumptions, values, and methodological commitments that give rise to a visualization but are less readily visible (i.e., the grounding of the visualization and related processes; how data were captured and interpreted, why particular forms were chosen over others, and what those choices presuppose about data and the designer’s role). In our own teaching, this gap tended to announce itself in concrete moments: *a hand-drawn personal visualization that adopts the look of intimate data work without its relational grounding; a “social good” project signaling care through warm colors and community imagery before any community engagement had taken place; a physicalization whose conceptual ambition outran the tools and time available to realize it.*

A shared attentiveness to such moments is what first brought the eight of us together, and the conversations that followed grew into this position paper. Drawing on critical discussions of visualization research and design [10, 11, 12, 26], the values inherent in dominant visualization practices [33], and the conventions that shape our interpretation of visualizations [20], we ask: *What is happening in moments where a visualization’s surface sits at some distance from its substance? What do these moments reveal about how visualization is taught and learned? And how might the conditions of our teaching contribute to producing that gap?* We do not attempt to answer these questions definitively. Instead, we use them to examine our own teaching and to invite critical reflection on what and how we teach in vis education, and on how our teaching practices influence students’ approaches to visualization.

Our contributions are threefold. First, we present **eight situated reflections** drawn from our own experiences as visualization educators across computer science, design, and interdisciplinary programs in North America and Europe (see Figure 1). These reflections represent more than 45 years of collective teaching experience in visualization, spanning several institutions and undergraduate through graduate levels. Second, we present a synthesis that draws out **four tensions concerning intentionality, interpretation, pedagogical structure, and misalignment**. Lastly, we offer a set of **reflective probes** for vis educators to bring into their own teaching; these are questions we continue to work through in our own teaching contexts, formal and informal.

2 RELATED WORK

This work sits within growing critical discussions that question the assumptions embedded in visualization research, design, and education. Scholars have challenged the notion that data are neutral entities, emphasizing instead that they are shaped by the contexts and practices through which they are produced and interpreted [11, 12, 13]. Correll [10] argues that visualization practice often obscures the labor, affected populations, and design choices that shape its ethical character. Others have questioned the predominantly positivist grounding of visualization, where values such as objectivity, universality, and efficiency often remain implicit even as they shape what counts as rigorous or legitimate practice [1, 26, 33, 35]. These critiques shift attention from visual form alone to the commitments

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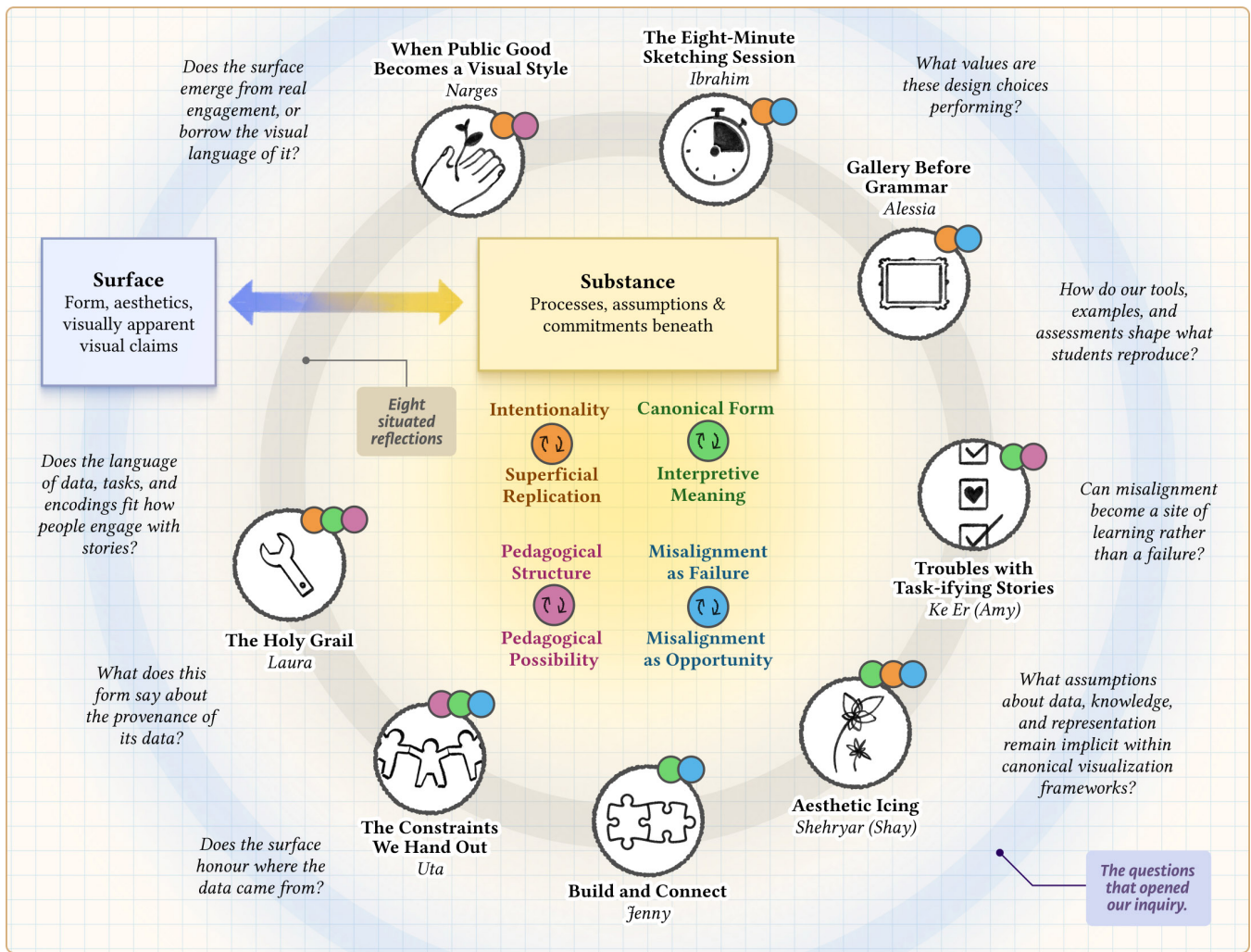


Figure 1: A layered overview of our inquiry into **surface** and **substance** in visualization teaching and learning. The outer ring (blue) holds the questions that opened our inquiry; the inner gray ring presents our eight situated reflections (Section 4), each identified by author and title. At the center (yellow glow), we outline substance, alongside the four color-coded tensions that emerged from our cross-case analysis (Section 5). Each reflection carries colored dots keyed to the four tensions, marking those most salient in that case.

and values that make such forms meaningful. Visualization educators also raise questions about how such commitments are introduced, reinforced, or left unexamined within teaching practices.

Several bodies of visualization research help us examine what a visualization appears to claim and the processes that support it. Hullman and Diakopoulos [16] show how narrative visualizations frame interpretation through design choices that can appear natural or neutral at the surface. Kennedy et al. [20] similarly argue that visualization conventions do important cultural work by producing an appearance of objectivity, transparency, and factuality. Dörk et al. [12] propose disclosure, plurality, contingency, and empowerment as lenses for interrogating visualization practice. Ottley [29] reframes visualization style guides as value-laden artifacts, showing that the rules organizations circulate as best practice encode institutional priorities as much as perceptual evidence. These works position surface as a set of conventions, rhetorical signals, and values through which visualizations make claims.

Prior work has also examined ethics, rigor, and reflection in visualization. Correll [10] argues that visualization research involves ethical choices that cannot be separated from design, evaluation, or communication. Meyer and Dykes [26] argue for rigor in de-

sign studies through transparency, reflection, and situated reasoning. Literate visualization and design exposition offers concrete ways of making design reasoning visible by documenting decisions, alternatives, and rationale alongside the final artifact [34]. Related work on communicative visualization also shows that metadata and contextual information can affect how viewers interpret and trust visualizations [9]. These concerns become especially visible in civic and community-centered visualization, where design is inseparable from questions of power, participation, and democratic decision-making [4]. Systems such as *CommunityClick* [19] and *CommunityPulse* [18] show that inclusion and public engagement depend on sustained attention to process, infrastructure, and accountability—not just polished visual outputs.

Within visualization education, these critiques have prompted growing attention to what and how students learn about visualization. Bach et al. [3] identify challenges around interdisciplinary teaching, diverse learners, design judgment, responsibility, and assessment. Research on how novices approach visualization shows that learner expertise is multidimensional and cannot be reduced to technical skill or chart-reading ability alone [8].

Recent EduVis work has begun to examine visualization teach-

ing across disciplinary settings, including the difficulty of teaching visualization alongside data science and the practical constraints of critical visualization pedagogy within curricula [25, 30]. Closer to our focus are Roberts et al.'s contextual scenarios for teaching critical thinking in data visualization [32] and reflections on running creative visualization learning activities [31]. Related work on data physicalization, humanistic visualization, and affective public visualization expands vis education beyond technical skill toward agency, critique, materiality, affect, and situated meaning-making [2, 23, 24].

Despite this growing attention, less is known about how learners negotiate the gap between surface and substance—and how this gap relates to specific teaching activities. While prior work theorizes how visualizations make claims [16, 20, 33] and how design reasoning can be made visible [34], it does not examine how the gap between claim and grounding is produced, rewarded, and negotiated within teaching, which is the concern we take up here.

3 METHODS

This paper emerged from ongoing conversations about visualization and teaching that, over time, became a space for reflecting on our own pedagogical practices. As these discussions evolved, we invited additional vis educators into the dialogue and gradually formed the author team represented here.

What initially brought us together was a shared attentiveness to the gap between a visualization's surface and its substance, and we started to explore teaching-related manifestations of this gap in the form of a collaborative reflective inquiry [7]: a dialogical process in which a group of educators examines their own practice around a shared concern, reflecting individually and collectively to surface the tensions that teaching holds. Such inquiries are often oriented toward generating and testing changes to practice, with the aim of improving teaching and, ultimately, student outcomes. Our aim with this paper is to provide starting points for further research and discussion, where we seek to draw out and sit with the tensions our reflections reveal rather than resolve them. We take this surfacing work as a necessary precondition for future, more action-oriented inquiries.

Our reflective inquiry moved through four overlapping phases: group conversations (from which a shared set of reflective prompts emerged), independent written reflection, independent cross-case analysis, and collaborative synthesis.

Group Conversations & Reflective Prompts. We came together as junior and senior instructors and researchers across visualization and design from April to June 2026. Collectively, our teaching spans computer science, design, human-computer interaction, digital humanities, and interdisciplinary visualization programs across North America and Europe. Our teaching experiences reflect different disciplinary traditions, student populations, and pedagogical expectations. We began with an open-ended discussion about what visualizations present at their surface and how this aligns or contrasts with the intentions, values, and commitments beneath that polished form. These conversations centered around instances of surface and substance encountered in our own teaching, prompting us to narrow our focus (see Fig. 1 for the questions that opened our inquiry). The first author drafted a set of reflective prompts after the first session to elicit individual reflection from co-authors; the prompts below are a refined version of the originals:

- Describe a moment from your own teaching (e.g., an assignment or activity) in which a visualization's surface seemed to promise something other than its substance: where its form, aesthetics, or apparent values sat at some distance from the processes and commitments that produced it. How did you come to notice it? How did you read it: as a tension, as something generative, or as a more neutral feature of the work?

- Did the surrounding pedagogical environment play a role in this in any way (e.g., tools, examples, constraints, timelines, assessment, disciplinary expectations, course goals, etc.)? If so, how? You might consider what those conditions made easier or harder, more or less visible.
- What unsettled, surprised, or stayed with you in this case? What does it reveal about the relationship between surface and substance in visualization teaching and learning, and what does it leave open?

Independent Written Reflection. Each author then wrote a reflection independently (see Section 4). The reflections should not be read as representative of visualization education broadly; instead, they function as situated examples through which broader questions about surface and substance can be examined. Rather than harmonizing our writing, we preserved the variation. Appendix A describes each author's teaching context: years of experience, institutional and disciplinary home, levels taught, cohort sizes, and the conditions shaping how they read their own case.

Independent Cross-Case Analysis. The reflections were then read across cases. Three members of the author team worked through the full set independently, pulling out salient points from every reflection and clustering them into preliminary themes, loosely following thematic analysis [5]. Between passes we held two meetings in which we compared our separate clusterings, discussed how the themes were evolving, and returned to the reflections with those discussions in view. We share a snapshot of our process in Appendix B. We did not use a shared codebook or seek inter-rater agreement; differing readings were treated as a resource, and we arrived at the four tensions through dialogue.

Collaborative Synthesis. Finally, these independent analyses were brought together through collaborative discussion and close reading, allowing us to compare interpretations, refine emerging patterns, and surface tensions that resonated across pedagogical contexts. Where disagreements remained, we retained them as productive tensions rather than resolving them. Through this process, we arrived at the four tensions presented in Section 5.

4 REFLECTIONS

We present eight first-person reflections that are situated in each author's visualization teaching and learning experiences. Figure 1 offers an overview of the eight cases.

4.1 Aesthetic Icing—Shehryar (Shay)



Over the past several years of teaching visualization, I have found myself paying increasing attention to the relationship between the visual forms students adopt and the assumptions that accompany them. Students naturally look to existing work for inspiration, borrowing aesthetic conventions, compositional strategies, and visual languages they admire. These are not only aesthetic choices. They also carry particular ways of thinking about data, evidence, authorship, and the role of visualization itself. I have increasingly found myself reflecting on how to help students recognize these inherited assumptions and engage with them deliberately rather than simply reproducing them.

The Dear Data [24] postcard assignment is an example where this pattern surfaces clearly. I ask students to collect, document, and visualize personal data over several weeks, while reflecting on both the data and the choices involved in representing it. Some students honor the provenance of their data and situate their visualization within its context. Others replicate the language of hand-drawn visuals popularized through the Dear Data project and other work by designers using analog materials, without critically examining why those conventions exist, what values they communicate, or what relationships to data they were intended to support.

What feels off in this second case is that the replication stays at the surface. A hand-drawn bar chart, or a dataset rendered in the shape of a flower, are forms I have seen repeated year after year. What presents at first as humanistic engagement turns out to be aesthetic icing on a piece of work that has not done the relational or methodological work the visual surface claims.

This pattern is not specific to humanistic visualization. It points to a broader dynamic within visualization pedagogy. Objectivity, universality, and efficiency operate as the normative conventions of the field, expressed through the clean minimalist aesthetic, the absent author, the optimized chart type. These conventions are also reinforced by the systems through which visualization is created: the defaults, templates, and recommendations built into design tools encode assumptions about what visualization should look like, making some approaches feel intuitive and others more effortful or inaccessible.

These tensions have recurred in my instruction over the past years. They have pushed me to reflect on how to teach visualization differently. How do I make the values embedded in design choices evident to students? How do I get students to confront their biases and blind spots head-on, and to make decisions intentionally rather than by replication? How do I build this interrogation into the structure of my courses, so that it shapes the work from the beginning rather than arriving as critique once the work is done?

I do not have settled answers. What I am working toward, in concrete terms, is a pedagogy that asks students to articulate the relationship between their visual choices and the methodological commitments behind them. Does the surface align with the work underneath it, and has the student made that alignment a deliberate choice rather than a superficial one?

4.2 When Public Good Becomes a Visual Style—Narges



My reflection comes from teaching Human-Centered Visualization, Human Computer Interaction, Digital Civics, Civic Design and Computing for the Common Good within computer science, many of which have also welcomed students from other departments. Across these courses, I ask students to move beyond technical implementation and consider how interactive and visual systems shape people's ability to understand problems, express concerns, and participate in decisions. My course projects are typically structured as semester-long, team-based projects in which students, often working in interdisciplinary teams, identify a real-world problem, study stakeholders, prototype and test a system, and justify their design choices.

A recurring tension I encounter is that students often learn to visually perform “social good” before they fully understand the social, political, or epistemic commitments such work requires. A project may use warm colors, human figures, handwritten typography, community imagery, or inclusive language to signal care, participation, or public value. On the surface, the work appears human-centered and civic. But when I ask what community voices informed the design, whose data is represented, who benefits from the system, or what assumptions are embedded in the problem framing, the answers are sometimes thin. *The visual language suggests care, but the underlying process does not always make clear how that care was enacted.*

This tension is especially visible in civic and community-centered projects. Students are often motivated by a genuine desire to address inequity, climate change, health, accessibility, or urban problems. Yet the pedagogical structures around them can pull them toward familiar deliverables: a polished dashboard, a clean infographic, a persuasive story, a prototype that “solves” the problem. These outputs can make public engagement look tidy and complete, while the underlying realities remain unresolved, contested, and messy. Our teaching may inadvertently reward the appearance of impact over the slower work of listening, questioning, and making

uncertainty visible.

My background in fine arts makes me especially attentive to this tension. I deeply value aesthetics, materiality, metaphor, and emotional engagement. In my public-facing and community-centered work, I have seen how visual and material forms can invite participation, make abstract issues feel immediate, and help people connect data to lived experience. So the issue is not that beautiful, emotional, or evocative visualization is superficial. The issue is whether the visual form has earned its claims. Does the surface emerge from an intentional relationship with the data, the people, and the context? Or does it borrow the language of care, participation, or empowerment without changing the process underneath?

This is harder to teach than it might seem, because I cannot offer students a clean rule. Telling students not to reach for warm colors until they have done community engagement would turn intentionality into a checklist. But if intentionality has to be built into a project from the beginning (into how problems are framed, how communities are approached, how data is gathered) how do I structure a semester around that? How do I introduce those commitments early enough to matter without overwhelming students who are still learning the foundations?

4.3 Build and Connect—Jenny



Build & Connect is an activity and toolkit designed for workshop and public exhibition settings to facilitate discussion and community building by allowing participants to make visible their interests and potential connections [23]. It can be considered as a constructive physicalization toolkit that utilizes the analogy of pieces typically used for jigsaw puzzles. Each puzzle piece contains a word or picture to represent themes. By connecting puzzle pieces, a visual word cloud or collage emerges over time; participants can work on it individually or collaboratively, at the same time, or asynchronously.

The design of Build & Connect emerged from a co-design workshop I ran with members of the wider Glasgow Women's Library (GWL)¹ community to explore lightweight and inclusive ways of sharing and discussing interests and concerns and how these could be translated and made visible and explorable to others in physical form.

Drawing on common data physicalization methods [17], the workshop invited participants to use familiar craft materials to make physical representations of their interests, memories, concerns, and perceived connections within the GWL community. The activity was intended to explore with participants how they could make visible what mattered to them and how their interests might connect.

This reflection focuses on a misalignment between what I expected the activity to produce: a collectively legible form of data physicalization, and what participants actually made: personal, symbolic, affective, and metaphorical objects. Rather than producing a single mode of physicalization, the workshop outcomes moved across a spectrum from direct representation to conceptual metaphor, with many examples sitting somewhere between the two. Some participants used familiar symbols, colors, or objects to convey direct representations of their interests and associations, while others developed more abstract or metaphorical forms. For example, one participant's hand-drawn heart raises the question of what constitutes data in this context. The heart works through association and affect rather than measurable comparison. It does not quantify experience, but it can still make visible forms of attachment or collective memory central to the participant's interpretation.

On closer reflection, although the activity was introduced through open-ended making and familiar craft materials, I still carried an expectation that the outputs would become legible as a connected system of themes, rather than remaining as separate personal objects or symbolic responses. However, the workshop was not set

¹ <https://womenslibrary.org.uk/>

up around measurable data or fixed visual encodings in the first place. Participants were not given quantitative variables to translate into size, color, texture, or number. Instead, they were invited to work with interests, themes, memories, and relationships that had emerged through earlier community discussions. The gap, then, did not lie between conventional physicalization and the participants' outputs. It lay in my own frame as a visualization researcher, in the distance between the activity's open-ended framing and my expectation for its results to cohere into something recognizable as data physicalization. In this sense, the misalignment sits within my own assumptions as a visualization researcher: I wanted to make space for situated, personal, and metaphorical responses, but also expected those responses to become analytically linkable, comparable, and collectively interpretable. The participants' work did not lack substance, it held attachment, memory, and relationship. What it lacked was the surface I had been expecting: the legible, connected form I associate with data physicalization. The structure shaping that outcome was the interpretive frame I carried into it.

This raises broader questions about what kinds of knowledge are foregrounded when visualization practices prioritise legibility. Conversely, what kinds of knowledge may be excluded when affective, embodied, or relational forms of meaning-making are treated as outside the boundaries of data visualization or its dominant viewpoints. In participatory and community-based contexts, these questions become especially important because the "data" being worked with may not begin as numbers, categories, or variables, but as entangled stories, experiences, concerns, and relationships.

Rather than asking, What data does this object encode?, we might instead ask: How does this object move from experience to theme, from theme to thought, from thought to metaphor, and from metaphor to physical form? This may point to the value of design-ing activities that make room for ambiguity and metaphor.

4.4 The Constraints We Hand Out—*Uta*



"Let's get physical" is an activity aimed at engaging people in the process of data physicalization, regardless of their background and prior experience with data analysis and/or representation [17]. Core to the activity is a set of cards—data, activity, and scenario—and a range of physical crafting materials that are provided to participants as a concrete starting point for their physicalization process. Data cards present a small dataset to be physicalized, while activity and scenario cards represent activities physicalization could support and (social) settings in which the physicalization could be used. At the beginning of the activity, participants are provided one card of each type and are asked to pick crafting materials for their physicalization.

We (a team of vis researchers) designed this activity as an entry point to data physicalization in classroom or workshop settings where time is limited. The cards and materials act as easily interpretable constraints to get participants started with mapping data to physical and tangible materials. I have applied the activity in different variations and contexts, often with the aim of "democratizing" data analysis and representation. However, recent critical discussions on the (often hidden) values and assumptions embedded in data representation processes make me wonder how the constraints that form the basis of this activity perform. How do they influence participants' physicalization process and outcomes and their assumptions about data physicalization?

The data cards, for example, perform in their own way: Providing "prepared" data reduces the physicalization process to mapping data entities to physical, visual and tangible elements, without considering data capture and processing as integral parts of the data representation process. The form and format in which the data are presented to participants—even if provenance, missing values or uncertainties are somehow presented—still suggests a positivist notion of data as "given" entities of things that can be counted and

structured. Across workshops, participants sometimes questioned the notion of "data" itself rather than treating the cards as given, but this rarely manifested in the physicalizations that were created. This raises the question of how criticality can be built more directly into an activity format like this one—starting with the data in focus and their initial presentation.

The crafting materials also perform in their own way, suggesting data physicalization as a manual, playful, messy approach, which it can, but does not need to be. Participants sometimes described their outputs as "artistic" compared to the visualizations they were familiar with or even had created themselves using more "precise" computational tools. The emphasis on process over outcome did not always land. This raises the question of how to foreground experimentation, reflection, and even "failure," or unintended outcomes, more directly in the activity.

Finally, reflecting on the physicalization approaches and outcomes of these workshops, I observed many instances where there was a strong link between surface and substance. One participant group, for example, represented data about immigrants and asylum seekers in the form of visually and physically fragile chains of paper dolls. Rather than just focusing on the numbers presented on the data card, the group aimed to highlight the difficult and vulnerable situation in which immigrants and asylum seekers find themselves. Handing the physicalization to other workshop participants further emphasized the responsibility we as society have toward people that have to leave their countries and start a new life elsewhere. That said, I also observed many instances where participants reproduced familiar, often normative forms of data representation (e.g., a physical bar chart) without experimenting with the meaning of the constraints introduced by the activity cards and material characteristics.

We know from design practice and education that introducing constraints can be a productive approach to boosting creativity, questioning boundaries, and critical reflection. How can we as vis educators critically interrogate and experiment with constraints we routinely introduce (sometimes unintentionally) in vis activities? And: how can we get students to explore the boundaries and question these constraints?

4.5 The Eight-Minute Sketching Session—*Ibra*



This activity takes place within my computer science department, in a course where students develop a data visualization as part of a semester-long project. The eight-minute sketching exercise serves as an early, exploratory phase: I ask students to produce eight rapid visualizations of a single dataset before committing to a direction for their final project.

A trajectory becomes visible across those eight sketches, and it tells me something about how form and understanding move together. The earliest attempts tend toward conventional chart types (e.g., bars, lines, pie); forms that assume the data's value lies primarily in legibility and comparison. By the final sketches, the aesthetic shifts toward something more expressive, even artistic, reflecting a different assumption: that data can carry narrative, emotion, or interpretive weight. The arc moves from analytic transparency toward something closer to authorial voice.

This shift is usually implicit. Students rarely pause to explain why their visual language is changing or what assumptions about the data are shifting alongside it, and that's where misalignment can creep in. A late sketch might look confident and intentional, with bold colors and an unconventional layout, while the engagement with the data's actual structure remains thin. Time pressure pushed the student toward aesthetic risk before they fully understood what the numbers meant, so the form ends up signaling an interpretive depth the process hasn't yet earned. In past sessions, this surfaced only at critique, after the fact. A brief return-to-data step between early and late sketches would let aesthetic ambition and data fluency develop together, rather than letting one outrun the other.

But the same gap that creates this problem can also be deliberately put to use. When I ask students to find visual references they admire and adapt them to their own data, I'm asking them to intentionally import an aesthetic from one context into another. The productive friction comes from the adaptation itself: reconciling a borrowed form with data it wasn't designed for forces students to reflect on what that form actually communicates versus what it merely resembles. Here, misalignment becomes a site of learning rather than a failure: the difference is intent.

That distinction is what makes the eight-minute format itself worth scrutinizing as a structure. Its compression rewards intuition over deliberation, opening space for ambiguity and risk, but it may also foreclose the slower, more rigorous engagement some datasets demand. The open question I keep returning to is which notion of "good" visualization the activity implicitly privileges, a question with particular stakes in a department where technical rigor already carries its own weight.

4.6 Gallery Before Grammar—Alessia



This activity takes place within a design faculty, in a course whose explicit goal is to teach data visualization, culminating in a group project consisting of a poster and a data physicalization. I structure the course around a long, deliberate arc of exposure before any sustained hands-on work begins. I open by showing my own projects to convey what data visualization means to me, framed early through data humanism. From there, I move the course into emotional data viz, drawing on designers associated with that sensibility, including work like *Dear Data*, then back to the historical canon (Playfair, Nightingale), then theory (visual variables and models), then a wide tour of contemporary cases spanning single-chart design, editorial infographics, interactive storytelling, and physical and sonic forms. Only afterward do I introduce tool tutorials (Excel, RAWGraphs, Illustrator, Flourish) and smaller exercises (pin badges, a *Dear Data*-style exercise), ahead of the final poster and physical edition.

The relationship between outward form and process here is striking, and it sets up everything that follows. For most of the semester, the course's "outward form" is an expanding gallery of polished, conceptually ambitious references, spanning a far wider aesthetic and material range than students yet have tools to produce. The value I'm performing is that breadth of reference and a personal sense of "why this matters" should precede technical competence, almost as if vocabulary comes before grammar.

That sequencing plays out unevenly across student groups, and a misalignment becomes visible in how it does. Students with less of a design background may struggle to translate the conceptual ambition of the early lectures into their final outputs, while groups that include someone with a communications-design background pull the whole group's work toward that ambition. My response to this is structural rather than corrective: I begin poster review mid-semester, giving the gap time to narrow, while I leave the physical edition more open, and students respond to that openness with more confidence.

What makes this misalignment generative rather than simply a gap to close is the group format itself. Uneven skill levels within a team become a resource, producing work that's interesting precisely because it combines competencies no single student has alone. The *Dear Data*-style exercise functions similarly: a small, personal, intentionally imperfect format that lets students metabolize the grand examples on their own terms before the larger deliverables arrive.

That same gap resurfaces, though, in the toolkit itself. Excel, RAWGraphs, Illustrator, and Flourish make certain outputs readily achievable, but they do not explicitly support the physical or sonic forms I show as inspiration earlier, leaving a quiet gap between what's shown and what's technically scaffolded.

4.7 Troubles with Task-ifying Stories—Amy



My reflection comes from teaching a few visualization courses within a computer science department (which have been designed over the years by different visualization faculty). The courses start from and largely remain oriented around an algorithmic view of visualizations and people, i.e., visualizations are designed representations of data that help users perform tasks, answer questions, and solve problems [6, 15]. This has been incredibly helpful for framing the utility of visual representations for students with a computational background, and it also helps them get started with reasoning about the design decisions they need to make for user-facing interfaces.

One major outcome of these courses is a practical application of this framework, where students are given a data scenario/challenge and asked to provide a solution by building either an analytical dashboard or a visual data story. Along with delivering a web application, students need to give an oral presentation justifying their design decisions. While the dashboard designs can be justified comfortably using the language of data-tasks-design by students (and myself when instructing), I find it can be awkward to use the same algorithmic language for discussing storytelling design concepts, such as affect, interpretation, or literacy, as it imbues these concepts with algorithmic meanings and values.

I'm not convinced an algorithmic view of visualization maps particularly well onto how people engage with data stories. One assumption of this view is that people will perform tasks when they encounter visualizations, though it feels overly mechanical to frame "enjoying the moment" or "feeling a certain emotion" as a task. What language might better account for the visceral, unexpected, or surprising experiences when encountering a story?

Another assumption that comes with an algorithmic view of visualizations is an ideal state of data or visualization literacy that audiences can strive toward and that designers can optimize for. This suggests that interpretation can be explained through latent, possibly universal patterns, but we see as much evidence now that interpretation is contextual, e.g., culturally dependent, and will be influenced by someone's own subjective experiences with the phenomenon. At the moment, the storytelling module is a perfect chance to discuss with students the tensions in "task-ifying" stories by sharing multiple ways of thinking about visual representation beyond an algorithmic view of visualization. For example, the module describes different models for how we understand visual communication, narrative, and rhetoric.

At present, students are evaluated by how well they can justify their work using canonical algorithmic views and frameworks, and by how well I can interpret their work using the same framework. I wonder what other possibilities become visible when students are given the opportunity to reason using alternative frameworks?

4.8 The Holy Grail—Laura



The first assignment that I give, whether in the master-level visualization course I have taught or in smaller-scale workshops, asks students to visualize a tabular dataset using Vega-Altair (or a similar library) explaining at least one aspect of these data that the student finds interesting. The student must also provide an explanation of **each** design decision made and **how** the design supports the data story that they wish to surface. The performative aspect, i.e., the reality that the student constructs in translating data to visual, is the targeted selection of information alongside a procedural design strategy of marks and channel mappings that prioritize efficiency and objectivity. This constructed reality tends toward a simplified, sanitized representation of a phenomenon. The visual may surface an otherwise hidden pattern—what we often most strive for in visualization—or obfuscate in favor of whatever the student wants to emphasize.

I like the grammar of marks and channels as a structured way

to scaffold visualization design and to show that data visualization is more than woo-woo design sense. However, this neglects the larger rhetorical choices vis designers make, and the student would benefit from being introduced (gently) to this aspect and to reflect on the rhetoric of each mapping decision. Last year I used a dataset on hours of sunshine across various cities. One student picked the three cities that they had lived in through key periods of their life. Each city had been thoughtfully chosen with how they felt about their life during the cycles of sunlight over the years in each place, yet none of these qualities came through in their final visual, which was a relatively bland, faceted line chart. The **substance** of the choice never reached the **surface**.

Such output feels out of step with what we're increasingly finding in research. The aesthetics espoused by, e.g., Tufte, Wilkinson, Tukey, are not necessarily the holy grail for data visualization. Humanistic design choices can create a more effective visualization. As an instructor, I think it's time to go beyond encoding alignment to ask the student to explicitly consider narrative and emotion in data-visual mappings.

High-level visualization libraries, e.g., the Vega ecosystem, Plot, Plotly, are convenient to get students quickly into producing data visualizations with code. However, with ease of implementation comes a loss of (easy) customization. The result is a limited design space that tends toward a minimalistic aesthetic. These libraries then almost funnel students towards one or a few "correct" visualizations of a given phenomenon with a God's eye view. This funneling might make the work feel unbiased and rigorous, but I think the humanistic aspect of visualization is not something we should ignore. These high level tools make building that aspect harder.

5 READING ACROSS THE REFLECTIONS

Through the independent cross-case analysis, we identified four recurring tensions that appeared in various forms across the reflections. We present them separately for clarity, but they are interconnected and overlapping. For example, a student's visual choices may appear disconnected from their underlying process because they reproduce familiar conventions (T1), privilege canonical forms over interpretive meaning (T2), respond to constraints embedded in tools or assignments (T3), or deliberately use misalignment as a space for experimentation (T4). Figure 1 maps each reflection to the tensions most salient within it; the overlaps in that mapping reflect these interdependencies.

5.1 Tension 1: Intentionality vs. Superficial Replication

"What presents at first as humanistic engagement turns out to be aesthetic icing on a piece of work that has not done the relational or methodological work the visual surface claims."—Shay

Across the reflections (especially those of Narges, Shay, Ibra, Laura, and Alessia), there is a recurring tension between the appearance of intentional design and the processes that give design choices meaning. Students frequently encounter visualization through examples, conventions, software defaults, and admired works. In doing so, students may learn visual languages before they necessarily learn the assumptions, commitments, and values [33] that underlie the surface appearance.

This dynamic appears across multiple pedagogical contexts. Students frequently borrow from or reproduce familiar visualization repertoires, employ visual signals associated with care or community engagement, or adopt established visualization styles. In many cases, these choices are sincere and motivated by genuine interest. Yet the reflections repeatedly describe moments where the visual rhetoric of a project appears disconnected from the methodological, relational, or reflective work that those forms seem to imply.

The reflections suggest that an emerging challenge for visualization pedagogy is not simply teaching students how to create partic-

ular visual forms. Rather, it involves drawing attention to the epistemic and sociotechnical commitments tied to those forms that have been increasingly explored in recent work, e.g., visualization's socioindexical function [27] and its inseparability from societal forces and epistemic beliefs [1, 35]. Echoing McNutt et al. [25], we suggest that integrating criticality into curricula may encourage students to be more analytical and intentional about the relationships between visual choices and their underlying commitments.

5.2 Tension 2: Canonical Form vs. Interpretive Meaning

"Rather than asking, What data does this object encode?, we might instead ask: How does this object move from experience to theme, from theme to thought, from thought to metaphor, and from metaphor to physical form?."—Jenny

Visualization is often introduced as a process of representing information (drawn most directly from Uta, Jenny, Laura, Shay, and Amy). Students learn to select encodings, map variables to visual properties, support analytical tasks, and communicate findings clearly. These frameworks provide important structure and have become foundational within many curricula. Yet, across the reflections, situations repeatedly emerge that are not easily explained through representation alone.

In storytelling activities, students grapple with emotion, narrative, and interpretation [22]. In community-centered workshops and physicalization exercises, participants work with memories, experiences, concerns, and relationships rather than predefined variables [23, 4]. In these contexts, the goal is not always to communicate efficiently or optimize task performance. Instead, visualization becomes a medium for interpretation, reflection, conversation, and meaning-making.

Several reflections describe moments where participants produced symbolic, metaphorical, or affective forms that resisted conventional notions of encoding. Others question whether algorithmic or task-oriented frameworks can adequately account for experiences such as empathy, ambiguity, surprise, or emotional engagement. Although prior frameworks remain useful, they struggle to accommodate forms of reasoning grounded in narrative, rhetoric, embodiment, or lived experience. These ways of knowing are not opposed to analytical reasoning, but are often less visible within dominant pedagogical frameworks.

Taken together, the reflections suggest that visualization pedagogy may benefit from positioning representation as one way of engaging with data rather than the only one. Framing representation as one of multiple models [28] creates space for multiple forms of meaning-making and encourages students to consider not only what data a visualization communicates, but also how it shapes and is shaped by interpretation, experience, and context.

5.3 Tension 3: Pedagogical Structure vs. Pedagogical Possibility

"High-level visualization libraries, e.g., the Vega ecosystem, Plot, Plotly, are convenient to get students quickly into producing data visualizations with code. However, with ease of implementation comes a loss of (easy) customization."—Laura

A common observation across the reflections (drawn most directly from Amy, Laura, Narges, and Uta) is that visualization outcomes cannot be understood solely as the result of individual student choices. They are also shaped by the pedagogical structures external to them. Assignments, examples, datasets, software tools, timelines, assessment criteria, disciplinary expectations and institutional forces all influence what kinds of visualization practices become possible, encouraged, or difficult.

These structures serve important pedagogical purposes. Constraints help students begin complex design processes. Canonical

frameworks provide shared vocabularies for discussing visualization. Software libraries lower technical barriers and make visualization accessible to broader groups of learners. Structured activities can create opportunities for experimentation within limited classroom time.

Yet the reflections repeatedly point to a paradox. The same structures that make visualization teachable can also narrow what students learn to value, notice, and produce. Tool defaults can normalize particular aesthetic conventions. Assessment criteria can privilege and reward forms of reasoning that are easier to justify using established visualization vocabularies. Prepared datasets can present data as already collected and ready for representation, obscuring the interpretive decisions and the labor involved in curating what becomes data in the first place [10].

Put simply, pedagogical structure is an active participant in the production of knowledge in the classroom. The decisions educators make about tools, examples, datasets, constraints, and assessment criteria deserve the same critical interrogation we ask of visualization itself. If we expect students to examine the assumptions embedded in their design choices, we ought to exercise the same intentionality about the choices embedded in our teaching [31, 32]. This shifts our attention from evaluating outputs alone toward examining the pedagogical conditions that make some forms of visualization easier to imagine, justify, and pursue than others.

5.4 Tension 4: Misalignment as Failure vs. Misalignment as Opportunity

“When I ask students to find visual references they admire and adapt them to their own data, I’m asking them to intentionally import an aesthetic from one context into another. The productive friction comes from the adaptation itself.”—Ibra

Many reflections (drawn most directly from Ibra, Alessia, Shay, Jenny, and Uta) identified moments where visual form appears disconnected from process, but they disagree about whether such misalignments are inherently problematic. In some cases, the gap between surface and substance is a missed opportunity: visual rhetoric promises depth of engagement that the underlying methods or relationships do not support. Such mismatches can mislead audiences and undermine credibility. In other cases, however, misalignment can be generative, productive precisely because it is intentional. This perspective is often reflected in critical design practices [14, 21], where deliberate adaptation of unfamiliar visual styles, experimental metaphor-making, or cross-disciplinary mashups can produce productive friction. This friction allows the creator to surface assumptions, prompt critical reflection, and reveal alternative interpretive possibilities.

Across reflections, misalignment functions both as a pedagogical risk and a resource. Rather than treating alignment as an unquestioned norm, educators might ask: When does alignment serve clarity and ethical communication, and when does misalignment invite necessary critique, discovery, or empathy? This points toward a pedagogical possibility: making misalignment an explicit object of study, something students are asked to attempt, examine, and reflect on. Students might be invited to deliberately introduce misalignment. These moments may become occasions to confront the relationship between surface and substance more directly.

6 REFLECTIVE PROBES FOR THE COMMUNITY

The probes below turn outward. Where our earlier prompts asked each of us to revisit a specific moment in our own teaching, these questions are addressed to visualization educators more broadly. They emerged from the four tensions as we read across the reflections. Each tension raised a question that exceeded any single case; rather than asking “*what happened here?*”, we ask “*what conditions made this likely, and what would it take to teach otherwise?*”

We clustered these questions into three broad probes, each gathering concerns that recurred across tensions. Each probe begins with a broad question followed by more specific prompts that expand, complicate, or contextualize it. We recognize that not all questions will be equally relevant in every setting. They are offered as an invitation to vis educators who have encountered similar tensions in their own teaching, and we continue to work through these questions ourselves.

Probe 1: What do our materials teach about data and representation? The examples we show, the tools and libraries we use, the datasets we provide, and the disciplinary frameworks we introduce all shape how students understand data and representation.

- **Lineages:** Which frameworks and definitions do we introduce, and what do they assume about data, knowledge, and representation? Do those assumptions make some approaches easier for learners to imagine than others?
- **Defaults:** Which forms does our tooling make easy to produce, and which does it constrain or make hard to envision?
- **Exemplars:** Whose work do we choose to show, and what does that selection suggest about what kinds of work are valued, successful, or considered professional?

Probe 2: How do our pedagogical structures shape the ways learners approach visualization work? The structures we put in place carry assumptions about what learners should prioritize and what constitutes successful work.

- **Constraints:** How do activities, assignments, deadlines, the culture of the setting, disciplinary expectations, etc., shape the work that learners produce?
- **Slowing Down:** Does our teaching make space for learners to slow down, examine, and reflect on the assumptions behind their work? What questions do we pose to help them confront the biases and commitments that shape their thinking?
- **Misalignment by Design:** Where might a deliberate mismatch between surface and substance become an object of study rather than an error or oversight?

Probe 3: What do we count as substance, and how would we recognize it? Reasoning shows up in process, in revision, and in what a learner can say about the alternatives they set aside. Are we asking for and evaluating meaningful evidence of that reasoning?

- **Assessment:** Are we assessing the artifact, the learner’s account of the work, or the relationship between the two?
- **Reward:** Which kinds of reasoning does our assessment recognize, and what does it weigh most heavily? How does that compare with the qualities that we would name as central to visualization practice?
- **Forms of Evidence:** What might learners provide to show the reasoning, assumptions, and decisions they set aside? Which of those forms can we interpret with reasonable confidence?

Across our reflections, the relationship between surface and substance has proven to be anything but incidental: both are actively shaped by the conditions under which visualization is taught and assessed. These conditions are themselves shifting as AI-mediated workflows reshape what counts as design effort, reflection, and authorship, making it increasingly easy to privilege surface over substance. If we expect students to examine the assumptions embedded in their design choices, we ought to exercise the same intentionality about the choices embedded in our teaching. **We offer this paper and its probes as a situated entry point:** an invitation to slow down and make explicit the relationship between surface and substance—in our students’ work, and in our own teaching.

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A AUTHOR TEACHING CONTEXTS

Our reflections are situated accounts rather than a sample. And so, to accompany our reflections, we each wrote a paragraph below in response to a shared set of questions covering years of visualization teaching experience, institutional and disciplinary home, levels taught and students' prior knowledge, disciplines and cohort sizes, how our approach has shifted over time, and anything else about our context that shapes how we read our own reflection.

A.1 Shehryar (Shay) Saharan

Biomedical Communications, University of Toronto. I have five years of visualization teaching experience, primarily in formal settings with some informal teaching alongside. My main teaching is in the Master of Science in Biomedical Communications (MScBMC) at the University of Toronto, a design-focused and highly interdisciplinary programme concerned primarily with communicating scientific information through visual means. After students complete MScBMC, most enter the field as medical illustrators, animators, and designers. They arrive from a wide range of backgrounds, broadly either the natural sciences or design and art, in cohorts of roughly 16 to 18. In addition to the courses I teach that focus explicitly on information and data visualization, every course in the programme deals with communicating complex scientific information, and that concern is the common thread running through the curriculum as a whole. I have also taught larger bachelor's-level information and data visualization courses, offered as Health Science Communication courses within the BMC minor, with cohorts of around 50. These students come primarily from science-focused degrees and are motivated by creating visual communication materials for science. My approach has shifted considerably over time, especially in the past one to two years. At both master's and bachelor's level, I have been thinking about how to build critical visualization into the foundation of how I teach, rather than shoehorning it into a lecture or two. The values and assumptions embedded in visualization should be confronted, but I am still working out whether, how, and when those complexities should be introduced, especially in more introductory courses.

A.2 Jenny Long

Design Informatics, University of Edinburgh. I have three years of visualization teaching experience, including formal teaching at the master's level as well as informal experience such as facilitation in community-based settings. I have not moved between departments; my teaching sits across the design department and the informatics department. My formal university teaching experience has been at the master's level, with tutorial groups of 5 to 20. Students come from a wide variety of undergraduate disciplines and are enrolled in MA and MSc programmes, so their prior knowledge varies considerably: some arrive with strong visual, creative, or design skills but limited coding experience, while others have technical backgrounds and are more confident with programming but less familiar with design principles and visual communication. Their motivations often reflect these different starting points. Design-oriented students are typically interested in developing their coding and data visualization skills, while students from computing, engineering, or other technical disciplines often want to strengthen their understanding of design, visual communication, and human-centred approaches. My other facilitation work has taken place in community settings rather than university classrooms, and these contexts tend to involve different expectations and levels of prior knowledge. The reflection I contributed focuses on one such setting. It was shaped less by a formal curriculum, assessment requirements, or institutional learning outcomes, and more by participation, accessibility, and the particular needs of the community. I therefore frame my reflection primarily as an account of informal and situated learning, rather than as one grounded in a formal syllabus context.

A.3 Ke Er (Amy) Zhang

Department of Informatics, University of Bergen. I have five years of visualization teaching experience: three years of formal and informal teaching in a science communication context and two years of formal teaching in computer science, having moved from the former to the latter. In the former context, I gave guest lectures, workshops, and tutorials for senior bachelor's through postgraduate students in the natural sciences; cohorts were roughly 30 to 50. Broadly, their motivation was to visually communicate their research data and conceptual ideas to fellow scientists. At Bergen I have instructed two kinds of data visualization courses. One is a small course of 10 to 20 computer science students learning visualization theory and practical knowledge, who are typically interested in applying it in their thesis or future career. The other is an introductory digital competence course targeted at computer science novices in data-oriented fields (i.e., data science, economics, design, medicine, law); this course hosts upwards of 200 learners who range from bachelor's students to working professionals. The motivation is to give students theoretical and practical knowledge about visualization that they can use in their home fields. My reflection describes activities in the first course, but my sentiments apply to both types of courses that shape students' mental models of visualization. Over time my approach has incorporated more discussions of empirical evidence on visualization along with technical, hands-on activities. One further condition shapes my own reflection: as a PhD fellow, I do not have full control over the syllabi of the courses I teach. I can decide on the delivery and framing of the core concepts, but the syllabus has been built over time by who the course has belonged to (e.g., there's a strong history of scientific vis) and needs to fit within the context of their study programme.

A.4 Ibrahim Al-Hazwani

Department of Informatics, University of Zurich. I have four years of visualization teaching experience, all within computer science. I teach at the master's level, with classes of roughly 15 to 40 students and semester project groups of two to five. Most students arrive without any knowledge of data visualization but with a medium to strong level of programming. Their motivation is twofold: one is to gain the credit for the course, the other is to understand how to visualize data using their CS skills. The disciplinary context has not shifted over my time teaching. What is shifting is the role of AI, which is changing a lot of what I expect from students and from myself when it comes to data visualization. AI is moving fast, and so is our way of approaching the challenge of how to visualize data. My concern sits between a fast, AI-driven world and a slower, human one: how do we slow down enough to ensure the data we work with are "good," and how do we teach students to be critical, not just efficient?

A.5 Alessia Musio

Free University of Bozen-Bolzano (UNIBZ) and Istituto Europeo di Design (IED). I have approximately three years of teaching experience in visualization and information design, including formal university teaching, workshops, and guest lectures. My teaching has mainly been within design departments and design-oriented programmes: I currently teach Information Design and Visual Storytelling within the Master in Eco-Social Design at UNIBZ, and Information Design and Data Visualization at IED. Alongside academic teaching, I also conduct workshops and training activities for students and professionals. I have taught mainly at bachelor's and master's level, with cohorts typically between 30 and 50 students. My students are primarily from design disciplines, including communication design, information design, eco-social design, and related creative fields. They usually arrive with experience in visual communication tools but different levels of familiarity with

data, statistics, coding, and visualization principles. Their motivations vary: some are interested in developing a stronger visual language for complex information, while others want to explore data as a creative material and expand their design practice beyond traditional graphic design. My own background is in communication design, with a focus on information design and data visualization rather than computer science or engineering, and my perspective is shaped by my professional practice as a freelance information designer. Because I work on real-world projects for organisations, institutions, and companies, I often bring practical examples and professional workflows into the classroom, trying to bridge theory and practice so that students understand both the creative possibilities and the ethical responsibilities involved in designing with data. My approach has shifted from focusing mainly on the technical and formal aspects of visualization toward a broader understanding of visualization as a tool for inquiry, storytelling, and critical thinking. I increasingly encourage students to see data visualization not only as a way to communicate information clearly, but also as a process of exploring questions, making interpretations, and creating meaningful relationships between data, context, and audiences, and I place more emphasis on experimentation, physicalization, and alternative forms of representation beyond traditional charts.

A.6 Narges Mahyar

City St George's, University of London. I have approximately nine years of visualization teaching experience, primarily situated in computer science but across several institutional and interdisciplinary contexts. I taught at the Manning College of Information and Computer Sciences at UMass Amherst from 2018, and since 2025 I have taught at City St George's, University of London, including Human-Centered Visualization in the Diverse CDT. Before UMass, I co-taught an interdisciplinary Civic Design studio at UC San Diego that was open to students from any department. My own background spans electrical engineering, computer science and HCI, visualization, and fine arts, which strongly shapes my interdisciplinary approach. I have taught undergraduate, master's, and doctoral students. My visualization-specific formal teaching currently involves doctoral students, while my broader HCI teaching has ranged from introductory undergraduate courses to advanced graduate seminars, so students enter with very different levels of technical and methodological expertise. At the graduate and doctoral level, I place greater emphasis on theoretical foundations, state-of-the-art research papers, research methods, and substantial projects, while undergraduate teaching provides more structure and focuses on developing foundational HCI and design skills through hands-on work. My students come primarily from computer science, informatics, HCI, and data visualization, though I have increasingly taught and mentored across disciplinary boundaries: my earlier Civic Design teaching included students from across UCSD regardless of discipline or level, and my current visualization teaching involves doctoral researchers in a data visualization CDT. I have intentionally tried to make HCI and visualization accessible to students with diverse academic backgrounds. Cohort sizes vary widely. My Human-Centered Visualization course had 11 PhD students; across my broader HCI teaching, classes have ranged from 10 to 60 students at graduate level, roughly 65 to 100 in undergraduate HCI, and as many as 370 in a large undergraduate technical course. In terms of motivation, many students are strongly driven by the opportunity to make a meaningful difference in the world and to work on problems they genuinely care about. Longer-term projects that students can shape around a topic of their own choosing tend to be especially motivating, because they provide a stronger sense of ownership, purpose, and personal investment. My teaching has become increasingly student-centered, hands-on, project-based, and research-driven: I have moved away from relying primarily on lectures toward a mixture of short lectures, dis-

cussion, hands-on activities, working sessions, and substantial real-world team projects. I increasingly use current research to connect foundational concepts with emerging visualization and HCI problems, and I adapt the balance of structure, theory, and independent exploration to students' level and background, with continuous student feedback becoming an important mechanism for iteratively adapting my courses.

A.7 Laura Garrison

Department of Informatics, University of Bergen. I have been teaching visualization for eight years, across both formal and informal settings. My university courses are mostly master's level; student supervision has included bachelor's through PhD level, and the workshops I have taught over the years are predominantly PhD level. All students have at least some background in informatics, anywhere from 2.5 to 6 years typically, although more recently I have taken on students with more of a design background and minimal informatics experience (e.g., one semester of basic programming). Cohorts are usually quite small, typically 5–30 students or participants. My semester courses have usually drawn computer science (informatics) students, but this is broadening to natural science students; workshop participants have ranged across informatics, physics, biology, and medicine, with humanities and design also coming into play in the last couple of years - partly due to trends in research topics that the community is shifting toward, and partly as I and my research become more known in other faculties at my university. My own background is very mixed. I started out in the natural sciences studying anatomy and physiology, then worked for several years in tech startups, first as a medical illustrator and then as a content director, before transitioning into informatics and data visualization. The communicative and storytelling aspect of medical illustration, alongside my grounding in the scientific method, has informed my research and educational aims. My approach to teaching has shifted along with my research interests: where at the beginning I focused more on the algorithmic side of visualization design and development, I now focus increasingly on the subjective and interpretive aspects of the visualization process, and the role that individual choices and backgrounds play in both the design and interpretation of a given visual of data.

A.8 Uta Hinrichs

School of Informatics and Edinburgh Futures Institute, University of Edinburgh. I have eleven years of visualization teaching experience, mainly in computer science and in interdisciplinary institutes such as the Edinburgh Futures Institute. I teach mostly at MSc level, alongside workshops that are mostly MSc level, some doctoral, and some outside the academic context altogether. Class sizes have ranged widely, from large-scale courses of over 100 students, to mid-size courses of around 40, to small workshops of 12. For most students I have taught, the course was their first introduction to visualization, although they typically arrive with mixed levels of experience in visualization and representation, data analysis, and related computational tools. Most are interested in learning practical skills around visualization and physicalization: some are drawn more to technical aspects, others to design and critical perspectives, and some to all of these. A few have research ambitions, but this is not the norm. My teaching began in the School of Computer Science and has become more and more interdisciplinary over the years, across different institutes and with cohorts spanning design, computer science, business, and the humanities, sometimes all in one class, as is typical for the Edinburgh Futures Institute. My teaching has always involved a fairly practical approach, exposing students to traditional perception-driven design principles and exploring the practice of visualization through manual sketching, off-the-shelf visualization tools, and coding. Initially my courses followed quite pragmatic approaches, driven by seminal books by

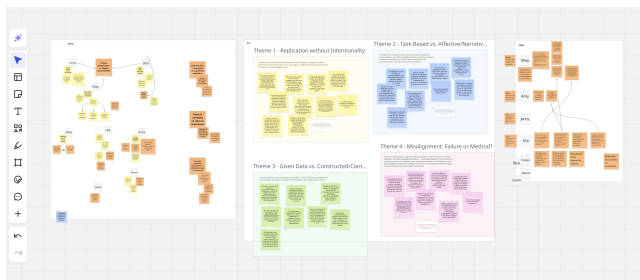


Figure 2: Working boards from the independent cross-case analysis. Three of the authors each organized the eight reflections on a shared digital whiteboard, clustering quotes and grouping emerging themes independently before the team compared interpretations and refined them through discussion.

Munzner, Ware, and Bertin. Over time I became interested in creative and experimental approaches rooted in design, and in critical perspectives rooted in the humanities, and I have since been working on weaving these into my teaching. My approach is always “in progress” and ever changing, especially now with the introduction of AI, which dominates how students think about and experiment with visualizations.

B INDEPENDENT CROSS-CASE ANALYSIS

Figure 2 shows the working boards from the cross-case analysis described in Section 3. Three authors organized the eight reflections on a shared digital whiteboard, clustering salient points and grouping emerging themes independently before we compared our readings. We include the boards as an example of how provisional this stage was.