Representational Affordances: A Cross-Media Approach to Teaching Data Visualization

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ABSTRACT

This paper presents a studio-based framework for teaching data visualization through three primary media: print, digital, and physical, with potential extension to immersive and hybrid formats. It foregrounds representational strategies across media, examining how spatial organization, interaction possibilities, and material properties influence perception, interpretation, and audience engagement. The curriculum follows a three-phase sequence of foundational skill development, media-specific studios, and comparative synthesis. Critiques and assessments are guided by a *Design Consideration Matrix* that addresses structure and space, dynamics and interaction, visual representation, materiality and embodiment, and access and inclusion. Drawing on examples from multiple course iterations, including a mood tracking case study, the paper shows how students explored potential types of data to collect and developed ways to represent them across formats, aligning design decisions with each medium's affordances and constraints. The approach fosters cross-media fluency, critical reflection, and the ability to match visual strategies to diverse audiences and contexts, balancing conceptual exploration with technical skill to prepare designers for evolving modes of data communication.

Index terms: Data Visualization Education, Multimodal Learning, Media Affordances, Studio Pedagogy, Cross-media Design.

1 INTRODUCTION

Data visualization transforms information into visual formats to facilitate understanding, discovery, and communication [1, 2]. The practice extends beyond conventional charts and graphs to include abstract encodings, tangible depictions, and immersive representations of relationships, sequences, and systems [3, 4, 5]. Visualization's power lies in enabling both granular insights and holistic understanding [1, 6, 7], with each medium offering distinct affordances: static layouts emphasize hierarchy and comparison, interactive views enable dynamic exploration, and physical installations leverage material properties to cue interpretation and foster collaboration.

In visual communication design education, teaching data visualization across multiple media broadens students' understanding of how data can be seen, felt, interacted with, and embodied. This cross-media approach proves essential in contemporary contexts where audiences encounter data through print publications, mobile devices, desktop interfaces, and emerging technologies [8, 9, 10]. Working across formats trains students to adapt visualizations to diverse technical constraints, interaction patterns, and accessibility requirements while developing the fluency necessary for inclusive, real-world data communication.

Rather than defaulting to software-determined outputs, this pedagogical approach emphasizes how visual meaning transforms across media, encouraging more intentional design decisions and deeper cognitive engagement with both content and form. Through iterative practice and critical reflection, students learn to recognize and harness the communicative affordances of each medium, developing the skills to create inclusive, context-aware visualizations that serve diverse audiences and purposes.

2 REPRESENTATIONAL STRATEGIES ACROSS MEDIA

This pedagogical study examines data visualization through three primary media: print, digital, and physical. While AR/VR activities were not implemented in this case study, immersive platforms represent an important hybrid modality that blurs physical and virtual boundaries by overlaying data onto objects and spaces or placing viewers within life-size, navigable environments [11, 12]. To contextualize this approach within the broader landscape, a brief discussion of AR/VR's opportunities and constraints for future iterations is included.

Each medium offers distinct affordances for organizing, interacting with, and communicating information. Despite their formal and interactive differences, students begin with a shared foundation in visual communication principles that support effective design across all contexts.

This foundation emphasizes data literacy: classifying data as quantitative, ordinal, categorical, or qualitative; identifying underlying structures such as temporal, spatial, hierarchical, or networked relationships [13]; and recognizing patterns of distribution and variability. Students then learn the visual encoding grammar of marks and channels, including position, size, shape, color, and texture, to ensure both expressiveness and perceptual efficiency [1, 2, 6, 12]. As skills develop, they apply layering, separation, whitespace, and contrast to manage visual hierarchy, enabling users to navigate between macro-level patterns and micro-level details [15].

Ethical considerations are integrated throughout the curriculum. Students learn to avoid misleading scales, biased sampling, inaccessible color palettes, and culturally exclusive symbolism [14, 15], reinforcing the importance of inclusive, responsible communication. The curriculum emphasizes iterative practice through critique, user feedback, and user testing [16, 17], creating a reflective cycle that helps students evaluate their visual choices and prepare for medium-specific challenges.

With this shared foundation established, students explore how core visualization principles manifest differently across print, digital, physical, and other formats. The following subsections examine how each medium shapes the perception, interpretation, and experience of data.

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2.1 Print-based Visualization

Print-based visualizations include fixed, static formats such as magazine spreads, newspaper infographics, posters, and screen-delivered PDFs. With predetermined dimensions and no capacity for real-time interaction, designers must embed complete narratives within single frames. This constraint elevates compositional hierarchy as the primary navigational structure, where grids, focal points, and deliberate visual flow [20] replace interactive mechanisms such as filtering or zooming.

Designers must balance perceptual efficiency with visual economy. Visual elements including shape, color, texture, and typography are selected to convey maximum meaning without overwhelming viewers. Layering and separation rely on whitespace, tonal contrast, and varied line weights to distinguish multiple data layers, since dynamic content controls are unavailable [3, 6, 19]. Narrative framing becomes critical: titles, legends, annotations, and visual cues must guide readers through structured stories while anticipating questions that cannot be resolved through interaction [22].

Print introduces material and production constraints including color profiles, resolution, trim size, and paper stock [21, 22], which directly influence palette choices, font sizing, stroke thickness, and layout clarity. However, print also offers unique affordances. Its tactile quality enables physical features such as fold-outs (Figure 1) or overlays that actively shape reading experiences. The static nature encourages reflective pacing, allowing viewers to linger over and revisit details. Additionally, print's reproducibility and portability enable broad circulation across public and archival contexts.

Figure 1: Fold-out print piece designed as a poster-zine. This class project illustrates how print media can leverage physical affordances such as folds, panels, and tactile navigation to guide narrative structure and enhance reader engagement.

The permanence of print design demands greater precision and editorial rigor since once published, revisions are impossible. This constraint, however, can foster more deliberate design decisions and comprehensive consideration of user needs during the development process.

2.2 Digital Visualization

Digital visualizations are interactive, screen-based experiences delivered through web pages, dashboards, or mobile applications. Unlike fixed print layouts, digital formats support animation, scaling, real-time updates, and responsiveness to user input such as hovering, tapping, scrolling, filtering, and typing. These capabilities transform data presentation into a dynamic exchange where users issue queries through interaction and visualizations return context-specific results [23, 24, 25].

Designing for digital media presents distinct affordances and constraints. Interactivity must serve clear purposes, with each interface element such as buttons, sliders, or checkboxes supporting meaningful queries without adding unnecessary complexity. Since digital visualizations are inherently non-linear, designers must anticipate diverse exploration paths. Progressive disclosure, smart defaults, and consistent orientation cues help maintain narrative coherence as displays change state.

Clear feedback becomes essential for user confidence. Smooth transitions, visual highlights, and concise confirmations help users interpret their actions and maintain engagement. Responsiveness across devices adds complexity to layout and interaction design, requiring scalable graphics, flexible grids, and appropriate touch targets. Accessibility must be prioritized through keyboard navigation, screen reader compatibility, legible typography, and sufficient colour contrast [26, 27].

Digital visualization offers unique capabilities including personalization, layering, and temporal unfolding. Viewers can explore multiple data dimensions, simulate scenarios, and track changes over time [25, 28]. These are capabilities that static formats cannot provide. However, these affordances introduce challenges including data latency, cross-platform consistency, and the need for continuous maintenance and version control.

When thoughtfully designed, digital media allow users to filter and compare data subsets, explore temporal changes, and engage with information through intuitive, exploratory experiences that support both analysis and storytelling.

2.3 Physical Visualization

Physical visualizations, or data physicalization, represent information through tangible, three-dimensional forms. Material properties such as texture, weight, scale, and spatial arrangement encode values, patterns, and relationships [4, 5, 31]. Unlike screen-based media, physical artifacts invite direct manipulation, embodied perception, and often social interaction, as viewers can handle, walk around, or even wear the data.

Designing effective physical visualizations begins with thoughtful material selection [32]. The chosen medium should carry meaning while remaining safe, durable, and suitable for repeated use. Spatial considerations are equally important: proximity, orientation, and elevation function similarly to layout and hierarchy in two-dimensional graphics but must also account for human ergonomics and how people move, reach, and perceive objects in space.

Since physical artifacts lack digital feedback mechanisms, designers must rely on sensory cues such as lighting, sound, or temperature to signal transitions or highlight specific meanings. Physical visualization enables multisensory engagement and offers alternative pathways to understanding. Accessibility in this context extends beyond visual design to include tactile markers, clear labeling, and inclusive sensory cues that support users with varied abilities [5, 33, 34].

These experiences can foster communal or performative engagement with data, encouraging dialogue and shared interpretation. However, they require more intensive labor and resources to produce. Iterative prototyping helps refine construction, test durability, and resolve issues related to transport or public display. When practical constraints are balanced with expressive intent, physical media can yield intuitive insights and embodied understanding that are difficult to achieve in digital or print formats.

2.4 Immersive Visualization (AR/VR)

AR and VR extend visualization into spatial, embodied experiences. Immersive environments support life-scale viewing, stereo depth cues, spatialized audio, and two-handed interaction, enabling tasks such as spatial comparison, path tracing, and collaborative exploration [35, 36, 37]. However, these technologies also introduce constraints including hardware costs, accessibility barriers, development and maintenance overhead, and potential simulator sickness [36, 38].

For the course iteration presented in this paper, AR/VR production activities were not implemented due to these practical limitations. Conceptually, AR/VR technologies share many objectives with screen-based visualization, such as overview-to-detail navigation and narrative guidance, while adding the spatial, embodied interaction and life-scale viewpoints characteristic of physical visualization [35]. This hybrid nature positions immersive media as a bridge between digital interactivity and physical presence, offering unique opportunities for future pedagogical exploration.

3 Pedagogical Approach

While each medium presents distinct possibilities and constraints for data representation, their educational value is realized through intentional curricular design. This section outlines a flexible three-phase framework that guides students through cross-media engagement, supports iterative learning, and fosters reflective design thinking (Figure 2).

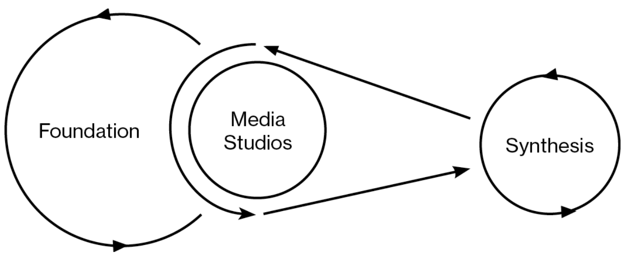

Figure 2: The three-phase course structure. Shared principles are introduced in the Foundation, explored through Media Studios using two or more selected media (print, digital, physical, immersive), and consolidated in the Synthesis, which informs subsequent iterations.

The *Foundation* phase provides students with a common vocabulary of data literacy, visual encoding, and ethical design principles. Five core design consideration categories are introduced (Table 1): Structure & Space, Dynamics & Interaction, Visual Representation, Materiality & Embodiment, and Access & Inclusion. Short, medium-agnostic exercises help students internalize transferable skills such as spatial hierarchy, color-coding for accessibility, and the use of metaphor to explore symbolic meaning and material resonance

The *Media Studios* phase consists of focused studios that engage with two or more media selected for the term. Instructors may combine print, screen-based digital, physical, and, where appropriate, immersive AR/VR formats. Each studio is guided by a conceptual theme or project focus, supported by distinct design briefs, core skills, and modes of data engagement. Critiques are framed using the design consideration categories: print critiques focus on spatial organization and typographic clarity; digital critiques address interaction pacing, accessibility standards, and responsiveness; physical critiques examine material constraints, fabrication strategies, and multisensory communication. When AR/VR is included, activities may involve low-fidelity prototyping, storyboard overlays, or critique of existing immersive scenes to highlight spatial and embodied affordances without requiring extensive development. In cases where a shared theme and data-collection protocol are used, consistent parameters allow direct observation of how medium shifts affect representational choices. In varied-topic cohorts, comparability is maintained through parallel design phases, critique structures, and evaluation criteria.

In the *Synthesis* phase, students analyze their medium-specific projects within a comparative framework. This cross-media analysis requires them to document and reflect on adaptations made across each design category. The final critique session creates a shared comparison matrix, revealing patterns of convergence and divergence across selected media. This process reinforces the understanding that while media shape meaning, all design decisions rest on shared theoretical foundations. The course then returns to the Foundation phase, preparing students to begin future projects with more sophisticated and flexible design approaches.

Table 1. Media-Sensitive Design Consideration Matrix

Category	Key Factors
Structure & Space	Scale and viewpoint Layout and anchoring Grouping and whitespace Navigation (wayfinding) cues
Dynamics & Interaction	Input modalities Responsiveness and latency Transition feedback clarity Exploration controls Collaboration and co-presence
Visual Representation	Mark choices Channel effectiveness and separability Labeling and annotation hierarchy Detail within overview
Materiality & Embodiment	Material properties and constraints Fabrication methods Durability and safety Environmental context
Access & Inclusion	Color contrast and text legibility Alternative cues (audio/tactile) Motion and comfort Safety and space Device access and affordability

This phased structure maintains curricular coherence while supporting deep engagement with medium-specific affordances. By cycling between shared foundations, focused experimentation, and comparative reflection, students build a deeper understanding of how medium choice shapes meaning and how thoughtful design adapts across contexts.

4 Studio Implementation

To explore how this framework operates in practice, a series of studio-based courses were conducted to test the concept across different media combinations and project contexts. These iterations served as testing grounds for applying shared foundations, focused experimentation, and comparative reflection within real classroom settings, allowing students to engage directly with medium-specific affordances while working toward coherent, contextually responsive outcomes.

4.1 Context and Scope

From 2020 to 2025, 15-week studio-based courses were offered to junior-level undergraduate students in the Visual Communication Design program at The Ohio State University, with each section enrolling 17-21 students. The curriculum spanned four iterations, with each term featuring two media components: print as the constant medium, supplemented by one variable medium selected from data physicalization, informational packaging design, or mobile dashboard interfaces. AR/VR was discussed as an adjacent modality but not incorporated due to limitations in time, technology availability, and accessibility considerations.

Project visualization topics varied each year, shaped by differences in student interests and emergent opportunities. While the pedagogical framework described in this paper advocates for a single shared theme to maximize cross-medium comparability, in practice the variation in topics allowed for creativity, personal investment, and responsiveness to real-world contexts. The examples presented here draw from multiple cohorts and themes, applying a unified analytical lens to show how the framework operates across diverse subject matter. This approach both illustrates the adaptability of the framework and models how a single-theme sequence could function in its most cohesive form.

Students entered with core visual communication skills including typography, layout, and image-making, and varied levels of experience in data analysis and fabrication. To establish a common foundation, the studio began with primers on visualization theories and principles (*the Foundation phase*). For each medium-specific studio, instructional refreshers aligned with the selected medium: visual explanation strategies, visual encoding principles, and grid-based typography for print; usability heuristics, interaction patterns, data display and navigation for screen-based digital; and material-driven data physicalization, multisensory engagement, and participatory design methods for physical formats. Although the media pairings differed across iterations, the structure maintained comparable processes and assessment criteria while adapting media selection to available resources and course focus.

4.2 Studio Sequence and Scaffolding

Each term's projects were organized to support cross-medium comparison, either under a fully shared theme or a set of varied topics adapted to the realities of that cohort. When a single theme was used, such as mood tracking, all students followed the same data-collection protocol and parameters, tracking similar variables over the same time frame to directly examine how representational choices shifted across media. In terms with diverse topics, comparability was maintained by aligning all projects to the same design phases, critique framework, and evaluation criteria, enabling the class to collectively observe how medium-specific affordances and constraints influenced outcomes regardless of subject matter.

The studio sequence followed the three phases shown in Figure 2: *Foundation, Media Studios, and Synthesis*, with approximate time allocations of 20–25%, 55–65%, and 10–15%, respectively. Formative critiques and revisions created iterative cycles between phases, allowing targeted refreshers and retesting in Studios before final consolidation in Synthesis. Section 4.3 provides media-specific briefs and representative outcomes.

The *Foundation* phase established shared practices before students branched into specific media. It opened with framing, ethics, and structured data-collection protocols that captured quantitative measures with qualitative context. Related short exercises covered visual encoding and perception, layout and hierarchy, color and semiotics, and baseline accessibility. Media-specific primers then prepared students for the term's selected formats, such as typographic pacing and proofing for print, interaction patterns and feedback for digital, and materials and sensory engagement for physical installation.

The *Media Studios* phase translated this foundation into applied projects while maintaining the shared theme or consistent process to enable meaningful comparison. Each medium followed the same scaffold: a design brief and media-specific primer, exploratory sketching, low-fidelity prototyping, and focused critiques that centered on communication goals rather than tools. Light validation was integrated into each studio. For digital prototypes, guided usability testing sessions were conducted mid-project. Students prepared short testing scripts aligned with their communication goals, identified key interaction tasks, and ran in-class testing with peers or invited participants. Findings were synthesized and applied to refine prototypes before reviews.

Across all media, structured critique sessions were scheduled at key checkpoints. These critiques, facilitated by the instructor, and when possible guest reviewers, were framed around the *Design Consideration Matrix*. By anchoring feedback in shared criteria such as Structure and Space, Visual Representation, and Access and Inclusion, students learned to give and receive actionable critique, draw comparisons across media, and connect feedback directly to their design decisions.

The *Synthesis* phase made cross-medium learning explicit. Teams mapped outcomes to the *Design Consideration Matrix*, explained which decisions changed or remained stable across media, and used collaborative digital whiteboards to share and compare findings. Insights from this reflection fed back into the Foundation phase in subsequent iterations, reinforcing the iterative cycles shown in Figure 2.

4.3 Media Briefs and Example Outcomes

To illustrate the framework in practice, this section presents three design briefs from a term that used a common topic: mood tracking. Immersive AR/VR was discussed as related context but was not implemented in these course offerings, so it is not included among the briefs or examples. The courses began with a shared data-collection protocol established at the start of the term: a short period of self-tracking (10–30 days) that recorded intensity, time window, and student-defined contextual factors. This initial phase marked the beginning of the data lifecycle, giving students firsthand experience with generating data and laying the foundation for understanding how collection methods influence the quality, scope, and interpretive potential of a dataset.

In the Print brief, students visualized their own self-tracked dataset directly. In the Digital and Physical briefs, the personal tracking experience served as a reference point for understanding mood data collection and visualization possibilities, informing decisions about what types of data might be useful in a dashboard for behavioral change or compelling to collect from the public to reveal broader patterns. Comparing how data collected through the same protocol could be translated and applied across media highlights distinct representational affordances and constraints.

4.3.1 Print Brief: Reflective Narrative

Students create a static visualization of their self-tracked period that integrates quantitative trends with qualitative notes. The focus is on structure and hierarchy to shape narrative pacing, clear encodings with separable channels, and annotation that situates patterns without distortion. Deliverables include a poster or booklet plus a concise rationale explaining encoding choices and relevant ethical safeguards.

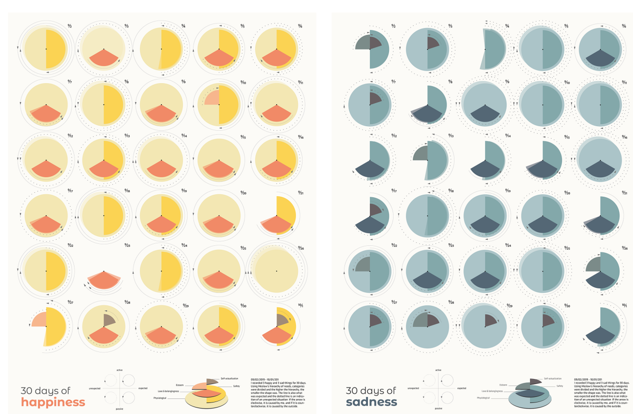

Figure 3: Example of a print-based mood visualization. To manage contextual complexity, the student reduced valence to a binary scale and mapped triggers to Maslow's hierarchy of needs.

4.3.2 Digital Brief: Personal Inquiry Dashboard

Students design an interactive interface prototype that supports logging and exploration of mood over time. The focus is on exploration controls (filtering, zooming, comparing windows), feedback clarity during interaction, and baseline accessibility (keyboard navigation, sufficient contrast, readable type). Students wireframe key views, prototype core interactions, conduct task-based usability tests with target users, and deliver a responsive dashboard that surfaces trends with on-demand detail.

Figure 4: Digital mood-tracking interface. This prototype connects daily mood inputs to music preferences and location, visualizing temporal patterns with tags, icons, and charts.

4.3.3 Physical Brief: Collective Engagement through Physicalization

Small teams of three to four students create a tangible artifact or compact participatory installation that invites on-site data contributions and visualizes the evolving dataset. The focus is on material choice and sensory engagement, sightlines and reach in a public campus location, and inclusive participation cues with clear instructions and labeling. Teams prototype at scale, pilot instructions with peers or passersby, and deliver a responsive object or installation accompanied by a simple setup guide.

Figure 5: Physical mood-tracking installation. Participants expressed current mood using combinations of three colored cards; simple materials yielded a wide range of expressive encodings.

While all three briefs in this example address the shared theme of mood tracking, they differ in audience, purpose, and interaction style. The print visualization supports introspective reflection within a fixed narrative structure. The digital interface enables interactive exploration and personalized engagement. The physical artifact fosters embodied or collective participation, often situated in public or social contexts. Together, these variations demonstrate that the form of visualization shapes not only what is communicated but also how, and to whom, it is communicated [33, 34]. Figures 3–5 present representative student projects from different course offerings, shown here under a common mood-tracking protocol to illustrate how similarly structured, self-collected data can be interpreted and represented across print, digital, and physical media.

4.4 Comparative Reflection Using the Matrix

The Design Consideration Matrix (Table 1) structured comparison at two key points: the project kick-off, to set expectations, and the final critique, to make cross-platform choices explicit. At the start, students translated the brief into initial decisions for each category: Structure & Space, Dynamics & Interaction, Visual Representation, Materiality & Embodiment, and Access & Inclusion. These decisions were based on either the shared protocol in single-theme terms or on each student's own project datasets in varied-topic terms. In the closing critique, they revisited the matrix to reflect on design decisions, linking observations to the key factors in Table 1. For example, they might explain how "navigation cues" were adapted between print and digital, or how "material properties" shaped symbolic meanings in physical formats. Students documented evidence under each category and articulated trade-offs across formats. Entries were compiled on a shared whiteboard so peers could compare approaches side by side.

Two discussion prompts guided critique: (1) identify one trade-off that improved communication in one format but required adaptation in another, and (2) identify one design decision that remained stable across media. Figure 6 illustrates how the Structure & Space category was used to contrast scale and viewpoint, layout and anchoring, grouping and whitespace, and navigation and wayfinding in print (red) and physical (green) outcomes. The remaining categories, including Dynamics & Interaction, Visual Representation, Materiality & Embodiment, and Access & Inclusion, were evaluated using the same process, although only Structure & Space is shown here for clarity. The visual mapping made design reasoning visible and provided a shared vocabulary for critique across cohorts.

Assessment was aligned with the matrix and standardized across formats. Rubric criteria remained constant, while descriptors were tailored to each format and mapped to the matrix categories. Criteria included concept and narrative clarity, creative approach, quality of visual representation and interaction, information clarity, communication effectiveness, and design reflection. For team projects, brief peer evaluations documented individual contributions and work quality.

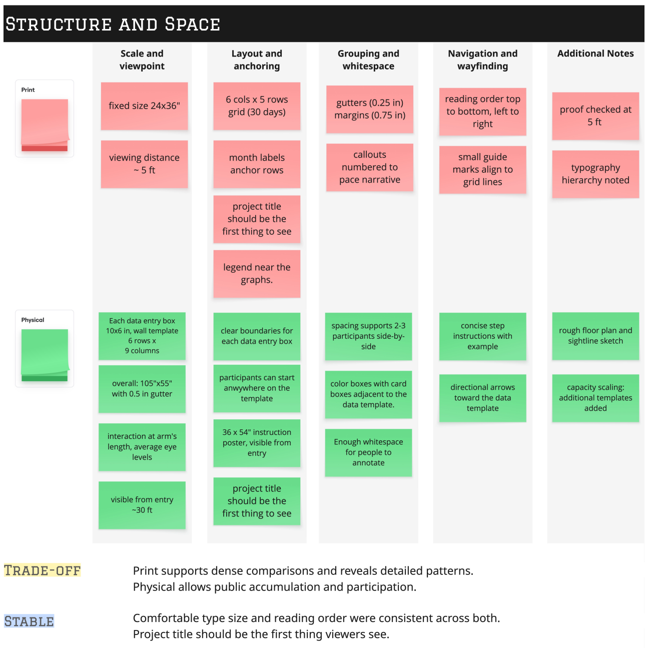

Figure 6: Example of the *Design Consideration Matrix* applied to the *Structure and Space* category to compare print (red) and physical (green) visualization prototypes.

5 Discussion

Implementing a cross-media approach to data visualization instruction reveals distinctive affordances, rich learning outcomes, and important pedagogical considerations. In the courses described in Section 4, print, digital, and physical formats served as the primary instructional focus. While some cohorts worked within a shared theme supported by a common data-collection protocol, others pursued varied topics selected from individual interests or available resources. In both cases, the framework supported direct comparison of how different media shape representation, and it can readily extend to immersive and hybrid environments where data is experienced through expanded sensory and spatial dimensions.

Print offers precision in hierarchy, pacing, and compositional control. Screen-based digital environments add interactivity, responsiveness, and temporal comparison, enabling dynamic exploration and iterative sense-making. Physical visualizations invite embodied interaction, transforming abstract concepts into tangible, spatial experiences. Experiencing these formats in parallel reinforces that a visualization's effectiveness depends not only on its content but also on the affordances and constraints of its medium.

Learning outcomes extend beyond technical skills. Students gain fluency in selecting and combining marks, channels, and organizational structures suited to both the data type and the medium. They learn to translate ideas across static, interactive, and tangible forms, designing for perceptual clarity and emotional tone while aligning visual strategies with the interpretive needs of diverse audiences. Medium-specific reflections, supported by structured prompts and peer critique, help students recognize how design decisions influence meaning-making and user experience.

Challenges are equally instructive. The cross-media model demands substantial time, access to specialized technologies or skills, and readiness to work outside one's comfort zone. Cognitive load increases when shifting between unfamiliar tools and production processes, especially for students with limited prior experience in fabrication or technical software. Many students expressed hesitation toward physical prototyping, particularly those accustomed to working almost exclusively in two-dimensional environments, and uncertain about planning for material properties, spatial layout, or public interaction. To address this, the class incorporated fabrication tool-use workshops and invited material-specialist instructors as guest speakers, helping students explore material possibilities and make informed selections. Despite the uncertainty, user engagement with these physical installations was striking: visitors lingered, contributed personal stories, and interacted in ways that survey-based formats rarely provoked. Such outcomes underscore the participatory and conversational potential of physical and multisensory data experiences.

To turn discomfort into productive learning [41], scaffolding is essential. Introductory workshops, collaborative team structures, and process-oriented feedback reduce intimidation and encourage experimentation. Assessing work consistently across varied media requires clear, adaptable rubrics that account for both medium-specific craft and overarching communication goals.

6 Conclusion

The cross-media approach integrates multiple modalities into a cohesive instructional model that cultivates versatile and critically engaged visual thinkers. While the implementation described here centered on print, digital, and physical formats, the framework is adaptable to immersive and hybrid experiences, each offering distinct ways of seeing, feeling, and interacting with data. This breadth accommodates diverse learning preferences and project contexts, whether students are working within a shared theme supported by a common data-collection protocol or pursuing varied topics guided by the same design phases and critique structure. In either case, the approach prompts students to move beyond surface-level depiction toward deeper consideration of form, meaning, and context.

Valuing the distinct qualities of each medium, the design course treats data visualization as a multimodal practice that is simultaneously technical, interpretive, and grounded in context. Students are encouraged to ask not only what to visualize, but also how and why, and to validate their decisions through real user engagement. This approach prepares them to navigate the evolving landscape of data communication with rigor, empathy, and creative intent. Future iterations could incorporate hands-on AR/VR prototyping to extend spatial and embodied affordances, foster deeper cross-disciplinary collaboration with fields such as psychology and computer science, and build partnerships with external organizations to create authentic, real-world cross-media visualization challenges.

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