"It's a Good Idea to Put It Into Words": Writing 'Rudders' in the Initial Stages of Visualization Design

Category: Research

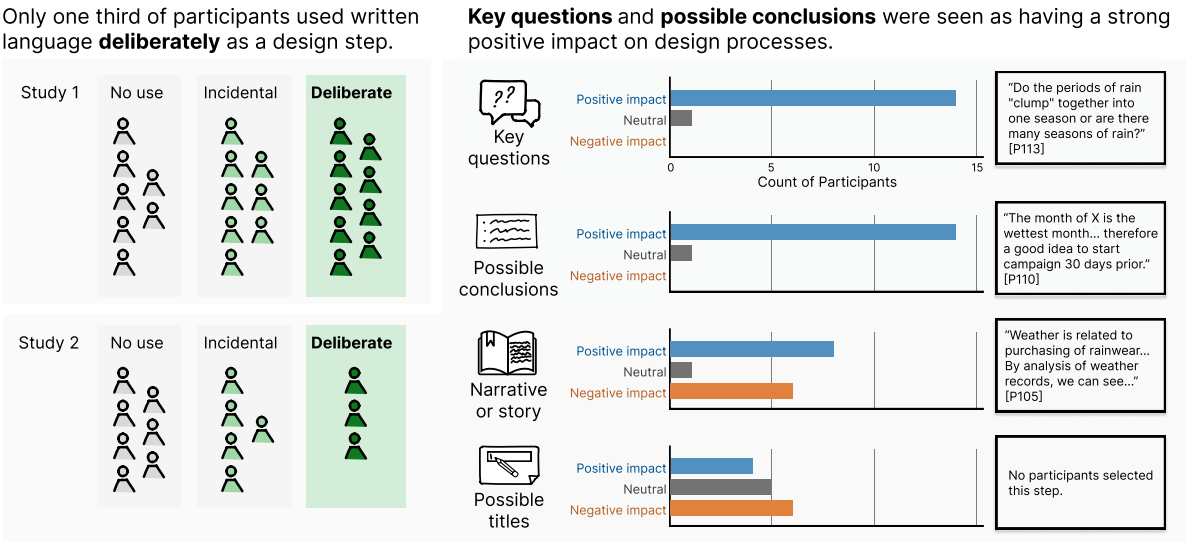

Fig. 1: Main findings from two interview studies. Both Study 1 and Study 2 found that visualization designers rarely use writing as a concrete design step. Of the variants proposed in Study 2, key questions and possible conclusions were seen as the most beneficial.

Abstract—Written language is a useful tool for non-visual creative activities like writing essays and planning searches. This paper investigates the integration of written language into the visualization design process. We create the idea of a 'writing rudder,' which acts as a guiding force or strategy for the design. Via an interview study of 24 working visualization designers, we first established that only a minority of participants systematically use writing to aid in design. A second study with 15 visualization designers examined four different variants of writing rudders: asking questions, stating conclusions, composing a narrative, and writing titles. Overall, participants had a positive reaction; designers recognized the benefits of explicitly writing down components of the design and indicated that they would use this approach in future design work. More specifically, two approaches — writing questions and writing conclusions/takeaways — were seen as beneficial across the design process, while writing narratives showed promise mainly for the creation stage. Although concerns around potential bias during data exploration were raised, participants also discussed strategies to mitigate such concerns. This paper contributes to a deeper understanding of the interplay between language and visualization, and proposes a straightforward, lightweight addition to the visualization design process.

Index Terms—Visualization, design, language, text.

1 Introduction

While visual activities, such as sketching or wireframing, are important and common steps in visualization design [33], the potential importance of *writing*, a critical tool in other creative fields, is underexplored. The process of visualization design is deeply intertwined with how visual elements are conceptualized, iterated upon, and ultimately deployed to convey meaning. Designing visualizations is often iterative and complex, as reflected in taxonomies of design practice [25, 28]. However, taxonomies and studies of design practice have not yet considered the use of writing in the design of visualizations.

For creative tasks outside of data visualization, taking time to write down a plan or outcome is a standard practice. For example, library science has long advised writing down the information need as a prelude to effective search [38, 50]. The introduction to Russell's *Joy of Search* [39] advocates this approach for web search:

> "I know, it sounds too simple to actually work. But if you take ten seconds to write down your question BEFORE you start ... you'll find your research process will be much, much more effective." (p. 7)

Research on essay writing instruction finds benefits in pre-writing steps, including writing outlines, lists, notes, or concept webs [14]. In visual endeavors such as animation and film, scripts and screenplays provide a narrative foundation for eventual visual output.

The origin of this paper stems from the direct experience of the authors in creating visualizations to serve as stimuli for a research study. At first, we struggled to determine what the narrative of the visualization would be and how we should write the accompanying text. We took a step back from the visualization itself to write a short paragraph describing the visualization and the story of the data. After writing this narrative, the design of the visualization was more successful.

In this paper we focus on the use of language to support the framing or the narrative of the visualization. We use the term **rudder**, which refers to a mechanism to steer a boat, as well as, more metaphorically, "a guiding force or strategy" [26]. A written rudder provides direction in the design of the visualization and helps to maintain focus on the message and goals of the project. Written rudders are also flexible, just as a boat's rudder may be pivoted to move the boat in a new direction. The purpose is to guide the design, similar to how a sketch acts as a starting point for determining visual representations. For both a written

rudder and a sketch, the final design may not be true to the specifications of the starting point.

We investigate two main research questions. First, **how do designers currently use writing during the design process?** Second, **what is the perceived impact of writing rudders on the design process?** In this paper, we use the following terms and definitions:

- **Visualization designer**: a professional who creates visual representations of data as part of a paid role, typically for a specific ask or objective. Also referred to as **designer** or **practitioner**.
- **Design process**: the dynamic, iterative set of activities undertaken while creating visual representations from raw data.
- **Written rudder**: hand-written or typed language created and/or used during the design process, describing the message, story, or key goals of the design itself. Also referred to as a **writing rudder** or **rudder**. A **rudder variant** or **variant** is a specific form of this language (e.g., questions the design may address).
- **Text elements**: typeface features on visual representations of data (e.g., captions, annotations, etc.).

To better understand the use and influence of writing rudders during the design process, we conducted two semi-structured interview studies with visualization designers.

Contributions: We contribute two interview studies with visualization designers which illustrate the potential impact of a recommended written step in the design process.

Study 1 finds that the deliberate use of writing as a design step among visualization designers is uncommon. When writing is used, it primarily informs the designer's understanding of the visualization's goals and the generation of creative ideas to display the data. We conclude that writing is underutilized in visualization design.

Study 2 builds upon these findings by exploring the tangible benefits and drawbacks of incorporating specific written rudder variants (shown in Fig. 1) into the visualization design process. Four variants were proposed, two of which were found to be especially beneficial to the design process. The actual written artifacts created from these steps may also serve important uses later on, such as evaluating whether a visualization has achieved its goals. Written rudders which take the form of statements or narratives were seen as better suited for later in the design process.

This research illuminates the utility of writing in the design process and suggests additional areas for future work and evaluation.

2 Related Work

2.1 Practical Insights from Visualization Design

Academic research often lacks actionable insights for practitioners, indicating a need to bridge the gap between research questions and design practices [35, 41]. In the broader field of HCI, there has been a shift towards practice-oriented research programs to enhance practical relevance of frameworks and theories [13, 21]. Some work in the area of visualization design engages with design practices in HCI, particularly in the case of design studies: researchers collaborate with domain exports to address problems through visualization systems [27, 40]. These systems can contribute practical solutions as well as theoretical insights into how designers create data visualizations. There is an ongoing conversation about making findings from design research more accessible and relevant to practitioners [15, 33].

When examining the design of visualizations in practice, researchers have found that the design process is nonlinear and iterative [2, 33, 35, 36]. Design involves insights from science and research, such as visual encodings and marks/channels, as well as artistic instinct, since visualization designers often incorporate elements of creativity into their designs. Designers often use guidelines, heuristics, or examples of past designs to assist in ideation and to avoid fixating on a particular design or approach [4, 35, 36]. Designers require flexibility in their approaches depending on the context, audience, and particulars of the data being displayed [7, 47]. This need is even more salient in environments with sensitive and/or important data, such as the COVID-19 pandemic [52].

There have been a few studies examining the use of written guides in the design process. Participants from Amazon's Mechanical Turk selected more effective visualizations when they were provided clear objectives (e.g., "Spot outliers within the data") [22]. Learning objectives are similar to the concept of written rudders that we explore in this paper. However, the learning objectives examined in prior work take specific forms and contain certain information, while 'rudders' are more flexible in form and content. In other words, learning objectives are one version of the kind of written guides that designers may use in the visualization design process.

Some researcher-designed tools consider the use of natural language in the visualization design process. For example, InkSight [23] allows visualization creators to augment their iterative sketching practices with generated data facts within a computational notebook environment. This method of exploratory data analysis supports concrete insights through natural language as well as freeform investigations through sketching. Storyboarding frameworks have also proved useful for the design of interactive systems, including visual analytics [43, 46]. Text accompanying the storyboard was particularly useful for understanding the overall narrative [43].

2.2 Frameworks in Visualization Design

Researchers have created a variety of frameworks to capture key steps in the design process [24, 25, 28, 40, 51]. These frameworks tend to incorporate similar stages of the design process: a stage for understanding the data and the overall context, a stage for generating ideas to show the data, and a stage for creating this design. While design frameworks are helpful for considering the different steps and actions that make up visualization design, none of them explicitly incorporate the use of written guides in any stage.

In this paper, we use the Design Activity Framework (DAF) as our main framework. In comparison to other models and frameworks, the DAF fits most clearly with the nonlinearity of design practices and is the most generalizable across design contexts. The DAF [25] provides four overlapping activities in the design process: understand, ideate, make, and deploy. Similar to the nested model, each stage typically provides an output for development in the following stage. However, these is more overlap and less linearity in the DAF process. Designers typically first *understand* the users, their data, and the project context. They then *ideate* different ways of communicating key information (e.g., different visual encodings) using sketches or low-fidelity prototypes [7, 11, 36]. These lo-fi ideas are then *made* into tangible prototypes and are *deployed* when the final design is decided and created in full. While these areas are intricately linked, they are also separable for individual study and attention. These activities or similar concepts are consistent across different frameworks of the design process, [24, 30, 40, 51] indicating their critical role in visualization creation.

2.3 Teaching Visualization Design

Teaching the design of visualizations involves not only imparting knowledge of tools and techniques but also fostering an understanding of the conceptual underpinnings that guide the effective communication of data. The teaching of visualization principles typically involves an understanding of visual encodings [10], communicating data clearly through data storytelling [19, 29, 44], and instruction in tools for visualization design, such as Tableau or d3 [6]. This often takes the form of hands-on projects and exercises to encourage the application of these teachings in real-world scenarios [3, 17]. Also recommended are design and redesign activities [45], peer critique [5], and design thinking [25, 49].

Data storytelling and narrative infographics are increasingly recognized as a crucial component of visualization design education [16]. The role of narratives or stories in data visualization allows for the development of broader skills alongside visualization techniques [3]. These broader skills are necessary in order to prepare students for the less structured and more situated environments of data visualization practice [34].

Writing activities have some precedence in teaching data visualization design. For example, the planning for a redesign can be written

down, or peer critique can be documented for later reference. Worksheets formalize some of these steps, requiring the student to think through specific steps in creating and conceptualizing a visualization [9].

2.4 Text Elements in Visualizations

Although visualization is focused on spatial depictions, text elements are important, and the impact of language in visualization has recently become a growing area of interest in visualization research (e.g,. [1, 8, 20, 31, 42, 48]).

We mention text elements in visualization here to distinguish them from the focus of this paper, in which we study the use of written language in the design process. There are instances where the two uses can be connected; a designer could use a written rudder to influence the title, annotation, or caption that ultimately appears in their final design.

3 Study 1

In the first study, we conducted semi-structured interviews with visualization designers to shed light on the following research question:

RQ1: How do designers use writing during the design process?

Demographic	Study 1 n = 24	Study 2 n = 15
Years of Experience		
1-3 years	3	4
4-6 years	9	4
7-9 years	7	2
10+ years	5	5
Time Spent Designing (per week)		
Less than 5 hours	2	2
5-10 hours	5	5
11-20 hours	7	2
21-30 hours	5	2
30+ hours	5	4
Industry Sector		
Broadcasting/Journalism	5	3
Manufacturing	3	0
Medical/healthcare	4	1
Non-profit/Government	3	4
Research	2	5
Scientific or Technical Services	4	1
Software	3	1

Table 1: Information about participants' experience and work context.

3.1 Methodology

Participants completed a 5-minute pre-interview survey about their work with data visualizations, followed by a 60 minute semi-structured interview on Zoom. The interview was recorded and automatically transcribed by the Zoom Cloud Service. They were compensated with a $30 Amazon gift card.

The pre-interview survey contained questions regarding features of the participants' work environments, such as the time per week they spend creating or working with data visualizations, the size of their company, and the number of people they frequently collaborate with. It also collected details about their work with visualizations, including the types of visualizations they create and the tools they frequently use, as well as information, such as the participants' level of experience, their gender, and their employment status.

Interviews began with an overall discussion of the participant's role and responsibilities in data visualization design, continuing on to discuss different aspects of their design process, such as the tools they used, their collaboration practices, and the use of writing in their design process. When possible, the participant and interviewer would discuss an example design to ground this discussion, selected by the participant prior to the interview. In some cases, this was not permitted by the participant's company. This portion of the interview took approximately 25 minutes. The rest of the interview examined designer use and implementation of text elements, though these responses are out of the scope of this paper. The full interview protocol can be found in supplementary materials. Participants are referred to with their assigned ID number [P#].

3.1.1 Participants

24 visualization designers participated in this study. Participants were recruited from the Data Visualization Society (DVS), News Nerdery, and public posts to X (Twitter) and LinkedIn. To be eligible for this study, participants were required to be based in the United States, be fluent in English, and spend at least a portion of their time at work designing or creating visualizations. These eligibility requirements were aimed to provide some consistency across participants and ensure study-relevant experience.

22 of the participants were employed full time, with one participant employed part time and another unemployed, looking for work. A majority of participants were women (14), with eight men, one non-binary person, and one trans man. Most participants worked in medium-sized (7) or enterprise-sized companies (11). Further information on participants can be found in Tab. 1, and supplementary materials.

3.1.2 Coding

Interviews were coded along three dimensions: the design outcome, writing in their design process, and the specific phase of the design process during which writing was used, when relevant. Descriptions of each code can be found in the codebook in supplementary materials.

The codes for the **outcome** dimension were developed post-interview, derived from the common outcomes mentioned by participants in the interviews via grounded coding. While these codes could be further refined during the coding process, no new codes were added. This code served to provide context for participant practices.

We also developed a separate dimension to address our main research question. While we knew we would code a dimension for **writing** prior to conducting the interviews, the precise codes (No use/none, Incidental, and Deliberate) were developed through the coding process. Additionally, we accounted for the **stage** of the design process that the rudders impacted. Stage codes (Understand, Ideate, Make, Deploy) were drawn from the Design Activity Framework (DAF) [25]. Prior to conducting the interviews, we considered different design frameworks. The DAF was chosen for its compatibility with other frameworks [24, 28] and its separate but intersecting stages of design.

The first and second authors engaged in detailed discussions about the dimensions and codes, applying them to two transcripts. After discussing the two transcripts, the codebook was then refined for improved clarity. Following this, the two coders independently coded the entire set of 24 transcripts. They met to discuss discrepancies and reach consensus on disagreeing codes. For the codes where consensus was not found, the third author was brought in as a tiebreaker to review the relevant transcripts, without prior knowledge of the codes applied by the first two coders. After considering responses from all three coders, consensus was reached on all coding categories. Interrater reliability (Cohen's kappa) for the two original coders was calculated for all codes and can be found in supplemental materials. There was moderate to substantial agreement between coders, with kappa values ranging from 0.662 to 0.75.

3.2 Results

We distilled two themes regarding the use of writing in participants' design processes. Overall, writing was not frequently used as a deliberate and intentional part of the design process, as shown in Fig. 1. When participants did use writing (deliberately *or* incidentally), this tended to occur in the early stages of designing.

3.2.1 Theme 1: Use of Writing is Relatively Uncommon

Participants tended to use visual methods in their design processes. Some participants (8/24) began their visualization process with sketching, and many participants (17/24) used sketching as at least part of their design process. For example, P19 said that while on an initial call with a client, they would "just sketch out the chart... just quickly take my pen and sketch out. Other times, if it's more complex, I'll draw a more complex chart in my notes." Across participants, this sometimes took the form of paper and pencil but could also occur using digital tools like Figma. P11 commented on the fast-moving landscape of these tools, "So we started out with Axure and Illustrator... now we are on Figma. God knows what we will be on next month."

Other participants (8/24) began their design process by putting the data directly into a tool to explore and visualize. The initial use of a visualization tool versus using sketching could depend on the complexity of the data, as stated by P18, "I'll try to sketch it out or just mock something up... with basic shapes to try to get an idea of what something is gonna look like. Or I'll take Tableau, Power BI and just throw the data in there, see what happens. And then start refining if it's less complicated." Putting the data directly into the tool facilitated speed and ease in the design process: "it's just easier to test different chart types that we're looking at" [P14]. The speed of changing chart types and variables in a tool often meant that, at times, it would take longer for the participant to draw the chart than it would to make the same chart in Tableau. The use of these tools also supported exploratory data analyses (EDA).

For most participants (15/24), writing was either not used at all (7/24) or not used as a distinct part of the design process (8/24). In the latter case, participants would mention taking notes or having written documents, but these were not integral to their design process. Around a third of participants (9/24) used writing in a deliberate way (more detail in Fig. 1). Only two participants *started* their design with some form of writing similar to a written rudder. For both designers, this took the form of a headline or written report from another collaborator.

Participants (7/24) who did not incorporate writing *at all* during their design process tended to think of the process as more internal. P1 stated, "I think it's happening internally. I don't list out key takeaways ... I guess it comes up in the process." In some cases, despite explicit probing from the interviewer, written rudders never came up as a component of the design process.

Participants (8/24) who *incidentally* incorporated writing did not consider it an important or consistent part of their design process. For example, P18 mentioned that they "try to keep notes as I'm going, cause as I'm coming up with a design, or really, as I'm working on it, I'll just have random stuff pop on my head." In this case, the use of language was sporadic and informal, serving primarily as a tool for capturing fleeting ideas rather than a formalized element of the design methodology.

Participants (9/24) who *deliberately* incorporated writing in their design process tended to think of them as intentional steps, often mentioning without probing from the interviewer. This could take the form of a formal document, such as a "written and approved strategic plan" [P3] or "paragraphs that are really data heavy" [P13].

In exploratory reviews of the codes, journalists (5/5) and participants who created text and visual reports (7/10) used writing in a deliberate way. However, all journalists were among those who created text and visual reports, thus conflating the values.

Overall, the use of writing in the design process was relatively uncommon in our sample, with only about a third or participants considering it a pivotal or concrete step in their design process.

3.2.2 Theme 2: Language Used in Early Design Stages

For the participants who used writing in any minor capacity (17/24), this step most frequently played a role in the *understanding* stage of the design. In general, these writings set the scene for what the visualization addressed and the specific needs served.

Participants (11/15) relied on this step as a way to better understand the ideas behind the design and the key questions the design would be used to answer. P20 described their use of written language as, "After I have that initial conversation, I like write it all up. This is the question. This is the context. This is the data we're going to use. This is how we think we're going to communicate it." In other words, the preparation for the design is written out, with key questions and data attributes captured in concrete language prior to beginning the design. Another participant created a short description of " what the graphic is supposed to show, which is usually two sentences" prior to beginning the visual design [P17].

In data journalism contexts, the actual written artifact may come from sources other than the participants themselves: "I request [the story draft] because it's helpful for me... I'm less likely to make a mistake if I see the whole story, even if it's just reporter notes" [P6]. The language provides information on the problem domain, but it comes from a source other than the designer. However, in cases where journalists were writing their own reports, a similar process took place where the draft was written first, and data-heavy paragraphs were replace with "preliminary charts" for review [P13].

Writing was also used during the *ideate* stage of design (7/15), where participants were brainstorming different ways to address the needs of the design. For example, after finalizing the goals and intents of the design, P23 has "a whole notes document going of things that just occur to me."

4 Study 2

Following the findings from Study 1, we faced several open questions about the impact of writing on designer workflows. Is writing beneficial for designers overall, including those who may not typically incorporate them? What form should these steps take? Which stages of the design process do they impact?

We formulated four different ways that people might use written language in order to introduce the idea to designers and allow them to compare the options. These became the four writing rudder variants that we assessed in Study 2.

We conducted a second set of semi-structured interviews with a new set of visualization designers. This included a brief design exercise and a post-interview survey to address the second research question:

RQ2: What is the perceived impact of writing rudder variants on the design process?

We focused primarily on the design *process*, rather than the design *outcome*. Based on insights from Study 1, we focused this study specifically on the beginning stages of the design process.

4.1 Methodology

Participants completed a 5-minute pre-interview survey about their work with data visualizations. This pre-interview survey was the same as the one given in Study 1. This was followed by a 60 minute semi-structured interview on Zoom. The interview was recorded and automatically transcribed by the Zoom Cloud Service. After the interview, participants completed a post-interview survey and were compensated with a $30 Amazon gift card.

There were four distinct phases in the interview: designer role, introduction of variants, design exercise, and reflection. Interview materials can be found in supplementary materials. As in Study 1, interviews began with a broad discussion of the participant's role in designing visualizations. The interview focused the conversation specifically on the beginning of the design process, attempting to capture the initial steps a designer typically takes. This design exercise was piloted by three graduate students, five participants from Study 1, and six additional participants recruited for Study 2. The pilot studies helped to shape the scope of the data, the time frame, and the description of the design task.

After asking about the participant's design process and context, the interview moved to the next phase, where the interviewer introduced four possible written rudders that could be incorporated into the early stages of design, prior to bringing the data into a visualization tool. Specifically, these were:

- **Key questions**: Write down the key questions that a user/reader may use the visualization(s) to address.

- **Possible reader conclusions/takeaways**: Write down ideas for possible conclusions readers might make when viewing the visualization(s).
- **Narrative/story**: Write down a brief story that conveys the main points the visualization(s) might express.
- **Possible titles**: Write down ideas for possible titles for the visualization(s).

These four rudder variants were the most common amongst participants in Study 1 who used writing, with each of them being mentioned by at least two participants. The interviewer introduced the variants in a random order, then walked through an example of what each rudder variant might look like in a sample design prompt. The order of examples was also randomized. The interviewer asked if the participant had any questions on each variant or how it might be applied in the design process. They then asked the participant to reflect on all the variants discussed and to select the one they liked the best or found the most interesting.

Following the introduction of these interventions, participants went on to use their selected variant in a brief design exercise. This exercise was described via a pre-recorded video so all participants received the same information. Since the study focused on the beginning of the design process, the exercise was limited to 10 minutes. Participants were provided with one year of Chicago weather data: temperature, precipitation, and wind speed. They were asked to design a visualization or a set of visualizations for a marketing agency whose goal was to determine the optimal time to begin marketing a waterproof windbreaker.

The template for the design exercise can be seen in Fig. 2. Participants were provided the overall goal of the visualization, any specific client considerations they might need, and the audience for the visualization. This overview was set up to imitate the content received in initial conversations with clients (i.e., requirements gathering stage). If participants had other questions about the client's goals or interests (e.g., is there a particular temperature at which customers begin wearing windbreakers?), they were told to use their best judgment and to assume it aligned with what the client would say if asked.

The "writing step" in the template was replaced with the participant's selected rudder variant. Depending on their selection, participants were prompted to generate three user questions (displayed in Fig. 2), three possible reader conclusions, a 3-4 sentence story, or three possible titles for the visualization(s) they planned to make.

Pilot testing of this exercise indicated that designers felt under pressure when having their design process observed. Therefore, we opted not to observe the design process, since the time of the exercise was also short, and we wanted to limit the amount of external pressure placed on the participant. Participants were repeatedly assured that they were not expected to produce a final design, since this exercise was focused on the starting phases of visualization design. Participants were not asked to share their screen or narrate their process. They could use any tools they felt most comfortable using. In order to further remove external pressures to the exercise, the interviewer turned their camera and microphone off.

After 10 minutes had passed, the exercise ended and the camera was turned back on. The interviewer asked about how the "writing step" affected the process of getting started on the design. The participant commented on the impact of the selected variant on their design process and considered the other three variants and what their impact may have been. The order of the three variants were introduced was randomized.

Following the completion of the interview, participants took a 5-10 minute post-interview survey which asked them to further consider each of the four rudder variants and to rate their impact on the understand, ideate, and make stages of design from the DAF. They also rated the impact of the writing step on "getting started on the design." The act of "getting started" could fall within any of the other three stages of the DAF, depending on how it was internally defined by participants. In order to also capture this nuance, we added this question to the other DAF stages.

Ratings were made on a scale from 1 to 5. A rating of 1 indicated that the step would *negatively* impact the stage in question, a rating of 3 indicated that the step would have no impact on their design process, and a rating of 5 indicated that the step would *positively* impact the design process. All ratings were made in comparison to the participant's current design process. Participants also reported if they currently use a similar step (which did not have to be written) and if they would consider using a step like this in the future. At the end of the survey, they reported their overall industry of work and their typical design outcomes.

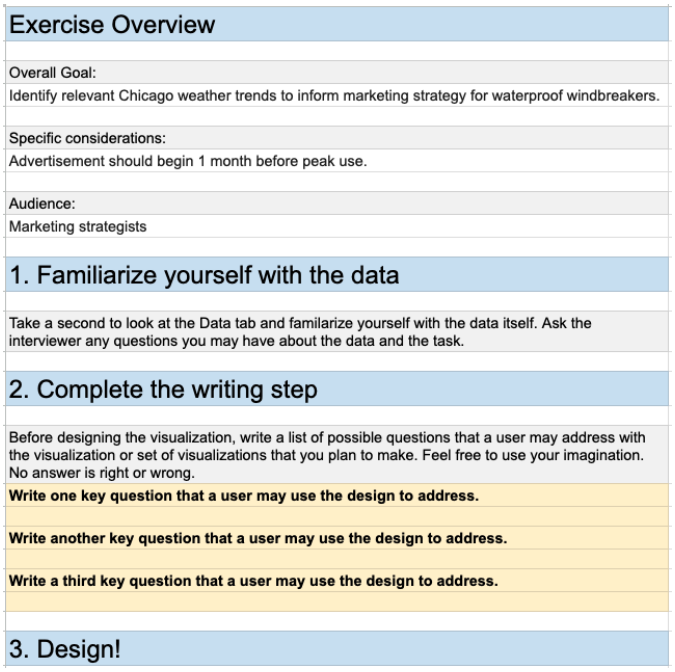

Fig. 2: Template for the design exercise in Study 2. The "writing step" was filled in with the rudder variant selected by the participant. An example is shown here for "User's key questions."

In our discussion of themes from these interviews, participants are referred to with their assigned ID number [P#]. In order to provide a clear distinction between participants from Study 1 and those from Study 2, ID numbers for Study 2 begin at 101 rather than 1.

4.1.1 Participants

15 visualization designers participated in this study. Participants were recruited using the same calls for participation as in Study 1 (DVS, News Nerdery, and social media posts). As in Study 1, participants had to be based in the United States, be fluent in English, and spend at least a portion of their time at work (in a paid role) designing or creating visualizations. 12 of the participants were employed full time, with two participants employed as students and one participant on leave. Again, a majority of participants were women (13), with two men. Further information on participants can be found in Tab. 1 and supplementary materials.

4.1.2 Coding

Interviews were again coded by the first two authors for the use of writing and the stage of the design process in which this occurred. The design outcome was captured in the post-interview survey. For the codes where consensus was not found, the third author was brought in as a tiebreaker. After considering responses from all three coders, consensus was reached on all coding categories. Interrater reliability (Cohen's kappa) for the first two coders was 0.796 for the use of writing and 0.754 for the stage of the design process.

In addition to these pre-defined codes, we also completed an open coding of the discussions about the rudder variants. The first two authors independently coded participants' feedback on the variants,

Rudder Variant	Understand Avg. (SD)	Ideate Avg. (SD)	Overall Avg. (SD)
Questions	4.53 (0.64)	4.27 (0.46)	4.30 (0.68)
Conclusions	4.53 (0.64)	3.93 (0.80)	4.20 (0.80)
Narratives	3.53 (1.06)	3.40 (1.18)	3.43 (1.13)
Titles	3.00 (1.20)	2.93 (1.28)	2.88 (1.21)

Table 2: Average ratings for each rudder variant for the understand and ideate stages, as well as the average rating overall. A rating of 4 or above indicates a positive impact on the design process, and a rating of 2 or below indicates a negative impact.

focusing on their likes, dislikes, and the impact of these steps. This process of open coding allowed us to uncover underlying themes and insights into how these steps influenced the design approach. After individual analysis, both authors met to discuss the emergent themes across the sets of codes.

4.2 Results

4.2.1 Current Use of Writing

As in Study 1, we coded each participant's use of written text and when in their typical design processes. Participants used text at these frequencies: deliberately (3/15), incidentally (5/15), and not at all (7/15). A smaller proportion of participants (20%) used written text deliberately in Study 2, compared to Study 1 (38%). This may be partially due to the goals of the Study 2 interview, which asked fewer questions about assessing the current use of written language than the Study 1 interview.

As in Study 1, most participants (6/8) who used writing did so when *understanding* the audience or goals of the visualization; a few (3/8) used language during the *ideate* phase, when generating ideas for how to show the information. These findings also support those from Study 1 as well as our decision to focus on the early stages of design in this study.

4.2.2 Intervention Results Overview

Overall, participants responded positively to the written rudders, assigning an average rating of 3.71 across the different variants and stages of design. (The average rating for each variant can be seen in Tab. 2.) In some cases, these written rudders were also seen as useful tools for assessing or explaining the final visualization design.

The most popular rudder variant was the writing of key questions (8/15), followed by possible reader conclusions (5/15) and narratives (2/15). These selections and representative quotes from participants can be found in Tab. 3. These quotes provide additional detail on participant opinions, which were generally positive.

Two variants (questions and conclusions) received relatively positive average ratings across stages. The other two variants (narrative and titles) did not fit well in the beginning of the design process; some participants felt that making a plan for the design too early could bias the exploration of the data. Overall, narratives were seen as relatively neutral, while titles received slightly lower than neutral ratings. This can also be seen in Fig. 1, which shows the overall category of the ratings (positive, neutral, or negative).

Most participants (11/15) noted that there were similarities between the rudder variants, as "they're all very similar, just approaching things at a different stage" [P103].

Although the participants only used one of the steps during the design exercise, we report their thoughts and reflections on all four written steps. Some of these results are thus based on *considering* the use of language in the hypothetical, while others are reflections from the *actual* use of the step in the design exercise. When applicable, we provide this context.

Participant responses to the writing step had an average length of 257 characters, ranging from 63 characters for the shortest response to 476 for the longest. Most responses (11/15) were concerned with time periods of extrema, particularly for precipitation (7/15), temperature (4/15) or wind (3/15), as relevant to the overall goal of the exercise in marketing waterproof windbreakers. Examples are shown in Fig. 1.

The next subsections describe the results in more detail in the form of three themes. Data related to the themes can be found in Tab. 4.

4.2.3 Theme 1: Written Rudders Add Design Focus

When discussing the rudders, participants commented frequently on the structure and focus they added to the design process. These comments were mainly associated with the writing of key questions (9/15) and the writing of example reader conclusions/takeaways (9/15). The narratives (3/15) and titles (3/15) were not often seen as providing additional direction to the design process, as shown in the 'Add Focus' columns in Tab. 4.

In comparison to how participants typically began the design process, writing rudders allowed for a more guided process. The interviews revealed that in their current practices, participants began the process by entering the data into a visualization tool (5/15), examining the raw data (3/15), or sketching (6/15). Only one participant started their design process with writing. Through writing rudders, participants felt they had a greater degree of focus in the design process (12/15). For example, P108 said that writing out possible conclusions helped to narrow down, "Which of the metrics would be most important to someone?" Written rudders also acted as guardrails to the design process, protecting against, "getting too excited and diving into the data, potentially losing focus of what the purpose is." [P103].

In addition to acting as a guide in the design process, written rudders also emphasized a closer connection to the audience's perspective and their uses of the data (8/15). When describing why they most preferred the key question approach, P107 mentioned, "I like to make sure that I am doing what the audience wants... The data isn't valuable unless you're giving it to the right people in the right format." As shown in Tab. 4, the narrative and title rudder variants did not seem to provide this user-centered guidance in the same way that questions or conclusions did.

While only hypothetical, future use of these written rudders was also received well. For both of the highest rated rudders (key questions and possible conclusions), almost all participants (14/15) reported that they would use the variant in the future in at least some contexts.

In general, participants viewed the written rudders favorably, as they helped to provide additional focus and structure to the design process. The listing of possible questions provided the most added benefit in bringing the design closer to the needs of the audience or user. Additional quotes regarding the design focus added by written rudders can be found in Tab. 3.

4.2.4 Theme 2: Using Rudders for Evaluation or Instruction

While the exercise completed by participants only encompassed the beginning of the design process, participants brought up the possible use of written rudders later in the design process (12/15). These comments should be seen as hypothetical, since they pertain to stages of the design process that participants could not reach within the 10 minute exercise time frame. However, some reflections are directly connected to past client scenarios.

In providing a guide for beginning a visualization, written rudders create artifacts to act as a comparison for the final design. Participants (11/15) mentioned that the tangible outcome of writing rudders would be a useful metric with which to judge a design's success or to aid in discussions with a client. Shown in the 'Evaluate Design' columns in Tab. 4, the questions rudder was most frequently associated with the possible use.

Along with the client or a potential user group, the designer could evaluate whether the resulting design measured up to the goals set out in the key questions (9/15) or conclusions (3/15) outlined prior to beginning the design. Completing this step could help, "at the end of the design process, to be like, wait a second. Are people actually coming away with what I wanted them to come away with?" [P102]. A narrative (3/15) could also provide design justification for the client ("Definitely when you're communicating with a team or with the client...

ID	Industry	Years Exp.	Use of Writing	Process Start	Selected Rudder	Representative Quotes about the Selected Rudder
101	Research	10+	Incidental	Examines raw data	Questions	"You need an objective and a plan, and you need to make sure those questions are open enough."
103	Nonprofit and Government	4–6	None	Sketches	Questions	"The establishing [of] the questions beforehand makes you sit down and just focus on the client first."
104	Nonprofit and Government	10+	None	Sketches	Questions	"Going back, saying, this is my goal... Can people answer this question?... I think that's super helpful."
106	Medical/ healthcare	10+	Incidental	Examines raw data	Questions	"It's a non- event. It's just part of [design]... It's just pretty fundamental."
107	Software	7–9	None	Inputs data to tool	Questions	"Building something that the user wants is the main goal. I think that doing [questions] is the most effective way."
113	Research	1–3	None	Sketches	Questions	"I think it's a good way to kind of organize things, cause I feel like a lot of times, it's just kind of in my head."
114	Nonprofit and Government	4–6	None	Sketches	Questions	"I like this approach and that it does require me to begin more with those [questions]."
115	Journalism/ Broadcasting	1–3	Incidental	Examines raw data	Questions	"I think it was a good framing to have in mind. But it definitely changed a lot as I like explored the data more."
102	Journalism/ Broadcasting	1–3	Deliberate	Sketches	Conclusions	"Coming up with what you want people to get out of this data set... helps me figure out what I'm gonna be visualizing"
108	Journalism/ Broadcasting	4–6	None	Inputs data to tool	Conclusions	"Having to write out kind of the actual conclusion that someone would see forced me to really be strategic."
110	Research	10+	Deliberate	Inputs data to tool	Conclusions	"I was surprised at how much it guided me in the process. Hadn't really occurred to me to to do it like that before."
111	Scientific or Technical	1–3	Deliberate	Written text	Conclusions	"You want to make sure that you haven't gone down a rabbit hole too far, and you're straying from the main point."
112	Research	4–6	Incidental	Inputs data to tool	Conclusions	"I would just have it as [a] starting point, because the takeaway can change."
105	Research	10+	Incidental	Sketches	Narrative	"It's a good idea to try to put it into words… It helped to figure out what the point is."
109	Nonprofit and Government	7–9	None	Inputs data to tool	Narrative	"It really focused me. I used what I wrote to immediately start thinking about what graph type I was going to use."

Table 3: Participant responses and quotes regarding the use of written rudders. Average ratings for all selected rudders were 4.25 or greater. All participants reported that they would use their selected variant in future contexts.

ID	Add Focus				Center Users				Evaluate Design				Create Too Early				Bias Exploration			
	Q	C	N	T	Q	C	N	T	Q	C	N	T	Q	C	N	T	Q	C	N	T
101	✓				✓															✓
102		✓				✓			✓		✓									
103	✓			✓	✓				✓	✓	✓							✓		✓
104	✓	✓		✓					✓	✓					✓				✓	✓
105	✓	✓	✓								✓					✓		✓	✓	✓
106									✓						✓	✓				✓
107					✓				✓							✓		✓		
108		✓																		
109	✓	✓	✓	✓																
110	✓	✓	✓			✓										✓				
111										✓					✓			✓	✓	
112		✓			✓				✓									✓		
113	✓	✓							✓					✓		✓		✓	✓	
114	✓	✓			✓				✓						✓	✓			✓	
115	✓				✓	✓			✓						✓	✓				

Table 4: Participant reflections on the impact of different rudder variants (Q = Questions, C = Conclusions, N = Narrative, T = Titles). Column names came from discussion of themes between coders. **Add Focus** and **Center Users** relate to Theme 1 (Sec. 4.2.3). **Evaluate Design** and **Create Too Early** relate to Theme 2 (Sec. 4.2.4). **Bias Exploration** relates to Theme 3 (Sec. 4.2.5).

it would be nice to have a narrative" [P105]) or simply to provide a point of engagement with the client about the visualization's goals.

In addition to supporting the client's goals for the visualization, writing rudders could also be used in academic or educational contexts. When describing their experience in writing out key questions, P110 described it as "the more intuitive place to start for, particularly a beginner. But it's not a necessary step for me." The rudders themselves sometimes felt educational as well. After completing the design exercise, P113 stated, "I'm always a little bit skeptical of this sort of thing because I'm like, This feels like school. But I actually really liked it." Considering these reflections, there may be a tailored approach to using rudders that is best suited for students or early-career designers.

4.2.5 Theme 3: Rudders Suited for Later Stages

While the narrative and title rudder variants were the least preferred by participants (as seen in Fig. 1), participants indicated that these variants could be better suited for later stages of the design process (9/15). When considering the narrative approach, P115 compared it to the "'alt text for graphic," stating, "I can't imagine writing it before." In one example, P110 already used a narrative step as a rudder in their design process when selecting the visualization that best communicates the key ideas: "I'll write text for each [visualization option]... I'll look at the text by itself to see which one reads better."

As shown in the 'Create Too Early' columns of Tab. 4, writing titles before exploring the data was often seen as premature (7/15). Titles tended to be one of the last steps in the design process, and the title of a visualization may change over the course of the design. Completing this step at the beginning of the design process seemed counterintuitive.

Shifting some rudder variants (conclusions, narratives, and possible titles) to later in the design process has additional benefits for data exploration. While written rudders provided a clear direction to the design process, this design direction guide could also introduce possible bias to data exploration (10/15). This is shown in the 'Bias Exploration' columns of Tab. 4. When describing the impact of the rudder on their design process, P112 mentioned, "[the design] was 100% based on on on these takeaways."

This kind of direction could be useful when focusing on explaining data, but some visualization contexts require open data exploration and unbiased analysis. For journalists like P102, this context may be different than for researchers like P106. For P102, "if there's no lead, there's no story... It's a very easy test that we really have to be able to answer." In this context, writing out possible takeaways or titles could ensure the data has a relevant story. On the other hand, P106 described, "For me, quality data vis means you don't know the answers. You're exploring the data."'

Participants suggested workarounds for the potential issue of bias, such as using a "fill in the blank" approach rather than referring to specifics of the data. An example of this approach is shown for the conclusions rudder in Fig. 1, using an X instead of a specific month. Keeping an open mind would be important when using these approaches, as mentioned by P108, " I do think it is helpful to be imagining what someone looking at [the visualization] might be like experiencing or thinking, but, on the other hand, I think you also have to be open to the idea of the data not saying what you might want it to say."

5 General Discussion

In exploring the role of writing within the visualization design process, these two interview studies offer a nuanced understanding of how written rudders can potentially enrich current practices in visualization design. Overall, participants in Study 2 responded positively to the suggestion of using rudders when designing visualizations, as represented by the quotes in Table Tab. 3. All participants indicated that they would be willing to adopt some form of this idea, despite the fact that only a few (3/15) use writing in their current practice. In particular, writing down reader's key questions and possible conclusions/takeaways emerged as the most preferred variants among designers. Writing a narrative about the chart could also be useful, but it may be better positioned towards the middle of the design process.

Incorporating into existing practice: While less than a third of designers across both studies deliberately incorporated writing into their design process, an additional third of designers use writing incidentally. Additionally, when reviewing the rudder variants in Study 2, designers often made comments that they used similar steps, "I do use a combination of these throughout the process" [P107]. However, these steps happen mostly internally, rather than explicitly.

Study 2 made this step explicit and tangible, something that was foreign to most participants. In comparison to other recommended design practices, such as cognitive walkthroughs, the addition of written rudders takes much less time and effort to incorporate. In this case, completing the writing step took less than the 10 minute design period for all participants. As such, written rudders would fit well with most designers' existing practices.

Creating detailed plans or task lists can improve outcomes, specifically in the cases of writing tasks or employee performance [12, 18, 32]. This occurs in part by increasing engagement with the overall objective. This can also have longer-term benefits, as planning tends to increase the likelihood of follow-through on key tasks [37]. Adding a concrete step in the visualization design process that encourages the creation of a plan or outline for the key points of the visualization may improve the overall focus of the design process.

Considerations for different contexts: In some cases, the process of designing a visualization is exploratory, and designers want to avoid any preconceived notions about the data that may bias this exploration. In other cases, such as in data journalism, the process is more explanatory, where the goal may be to make data understandable and accessible for lay audiences. To avoid bias in data exploration, designers could use *only* a series of open-ended questions to explore key pieces of the data without stating expectations of the data features. Designers could alternatively use an process similar to hypothesis testing. A combination of writing and sketching could provide an a priori understanding of how data features would look if different possible takeaways were true.

6 Limitations and Future Work

These interview studies provide insights into a previously underexamined written components of visualization design. Here we discuss key limitations and future work to address them.

Reflections in hypothetical: The primary goal of this paper was to uncover the current use of writing in visualization design, and ascertain practitioners' reaction to written rudders as a part of the design process.

Participant feedback is based on reflections and hypothetical scenarios rather than long-term application of the steps in regular workflows. This approach, while useful for forming an initial understanding, may not capture the complexity of actually using these practices consistently. Preferences expressed in hypothetical scenarios may not translate into actual changes in established design practices.

Future research should aim to transition from hypothetical scenarios to empirical evaluations, including the use of longitudinal studies to observe how designers integrate written rudders into their workflows over time. By observing the adoption and impact of these practices in a variety of real-world design projects, researchers can gather concrete evidence on the utility of written rudders, including barriers to integration.

Leaving out the design: This paper focused specifically on the design *process*, and the interviews were primarily about the early stages of creating a visualization. This focus excludes the direct impact on the design outcomes. This limitation was necessary to first establish whether designers see values from these steps. Without preliminary buy-in from the design community, assessing the effect on resulting designs would be premature.

Subsequent research should directly investigate how writing rudders impact the final designs. By comparing designs developed with and without these interventions, researchers can better quantify their impact on creativity, clarity, user engagement, and the use of text in the design. Evaluations of design outcomes will allow for a more concrete assessment of the benefits and limitations of written interventions.

Limited sample: These interviews were not conducted with a statistically representative sample of visualization designers. The most recent State of the Industry survey from DVS contains responses from 445 visualization designers based in the United States. Our sample size of 39 is a meaningful fraction of that number but is still small. Further work should explore more specific design contexts, such as data journalism, or more specific demographic categories, such as early-career designers, in order to provide more detailed understandings of these sub-populations.

7 Conclusion

This research has explored the role of writing in the visualization design process, revealing its potential to enhance clarity and intention during the creation of a visualization as well as to provide artifacts for evaluating designs at the end of the design process. Our findings suggest that by incorporating written rudders, such as formulating key questions or possible reader takeaways, designers can not only refine their goals for the design but also align more closely with audience needs. Future studies should explore the longitudinal impact of these practices on design processes and outcomes. Overall, these results reinforce the symbiotic relationship between language and visualizations, encouraging further integration of the two.

Supplemental Materials

All supplemental materials are available OSF, released under a CC BY 4.0 license. In particular, they include (1) interview materials for both studies and (2) analysis files used for participant distributions and exploratory data analysis.

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