Challenges and Solutions for Short-Form Data Visualization Instruction

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ABSTRACT

While data visualization is increasingly taught in semester-long courses and even in certificate and degree programs, there is also a growing market for short-form data visualization instruction. This paper outlines two major factors that influence the development of short-form data visualization instruction: audience type (broad or specific) and instructional focus (hands-on or conceptual). Apart from these factors, other relevant considerations include the fluidity of attendance, the comprehensiveness of the instruction, the availability of helpers, the temptation to flip the classroom, and the mechanisms for sharing materials. Specific recommendations accompany each consideration, along with links to resources.

Keywords: pedagogy, short-form instruction, recommendations, broader public.

Index Terms: • **Social and professional topics~Adult education** • Social and professional topics~Information science education • Social and professional topics~Informal education • Human-centered computing~Visualization

1 INTRODUCTION

Short-form instruction includes day- or week-long courses offered to a corporate audience, pre-conference workshops, short modules offered within courses that do not focus on visualization, or even professional development workshops offered by university libraries or IT organizations. Short-form instruction by definition gives an instructor less time to cover material that might be relevant to data visualization. Beyond simple time constraints, however, there are common properties of short-form instruction that influence the way that visualization can be taught. We focus here on the influence of audience type and instructional focus on pedagogical strategies.

2 AUDIENCE TYPE

Short-form visualization instruction may be offered to a broad community (e.g., the attendees of a conference, members of a university community) or to a specific group (e.g., the data analysts of a particular company, students in a specific class). While there are certainly exceptions, it is common for audiences to be more diverse when they are drawn from a broad community than when they make up a well-defined, existing community. The diversity of a broad audience manifests in various ways: diversity of interests, diversity of expertise, diversity of technological savvy, etc.

With a broad audience, instruction is likely to move more slowly. There will be additional questions about the content, and concepts or procedures will need to be explained several times and often in multiple ways. The risk of students falling behind seems higher with a diverse audience. Thus, when teaching to a broad audience, it is often helpful to distribute files that have been prepared for different stages of the demonstration, like a **cooking show**.

For example, you may wish to demonstrate the beginning of a visualization project, leading students through a series of steps to clean a dataset. If they fall behind or have trouble getting everything complete, you can have a prepared file that shows the end result of those operations. Students who are having trouble can switch to the prepared file for the next section, rather than fall irretrievably behind. Conversely, if you are teaching without computers but have an activity where students make sketches or have a discussion within a small group, you can prepare and present sample results to help students who struggled to complete the activity. (This technique works for more homogeneous audiences as well, of course, but it is especially useful for diverse audiences.)

In some cases, however, it may be possible to reduce the diversity of the audience, especially in terms of expertise. A clear and specific description of the plans for the workshops may help people understand more clearly whether the material will be at too high or low of a level for their current expertise. Sharing materials in advance may also help individuals make a more informed decision about whether or not to attend. Listing **prerequisite knowledge** and offering suggestions for how individuals might gain that knowledge before the workshop may offer a compromise between slowing the material down to a fully beginner level and running the workshop at a pace that leaves beginners behind.

The type of audience also influences the type of examples that will be most effective. Ideally, the data and visualization examples used in visualization instruction will be a close match to the interests and goals of the students. With instruction that is being given to a closed group, it may even be possible to request data from the students and prepare discussions and exercises around areas of specific concern to those datasets. At the very least, it may be possible to provide a **feedback session** where individuals who have produced visualization can take advantage of the expertise of the instructor (and their fellow students) to receive feedback about the form or content of the visualization.

The more diverse the audience, the harder it becomes to tailor examples. For a broader audience, it may be necessary to stick with a dataset that is likely to have wider appeal, or at least to one that has useful properties and interesting trends. For hands-on instruction, selecting datasets that help students learn extremely common chart types or data cleaning techniques – a sort of **Frequently Asked Questions (FAQ)** approach – may be the best way to anticipate the needs of the students. For conceptual instruction, try selecting example visualizations that highlight common problems, or common fixes to those problems.

3 INSTRUCTIONAL FOCUS

Two types of instruction – hands-on instruction and conceptual instruction – are especially relevant to data visualization pedagogy. In long-form instruction environments like university courses and MOOCs, both types of instruction are likely to be intertwined throughout the course. For short-form visualization instruction, the process is likely to be abbreviated, and it may be necessary to prioritize one focus over the other.

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Hands-on workshops focus on a particular software application or design process – for example, using Tableau to visualize the results of a survey. Designing short-form instruction around a particular tool or process offers many challenges. Selecting an appropriate dataset for the audience, mentioned above, is one of many difficult choices. If the tool being used requires that students type commands or formulas, consider distributing an electronic version of the instructions so students can **copy and paste** the formulas. For tools where the visualizations are created using a graphical user interface (GUI), any instructions should clearly outline the interactions that must be undertaken, using legible screenshots wherever possible. If the instructions are distributed through a website, it may be possible to prepare and include an animated GIF to demonstrate a particular process. (See [3] for an example.)

Another choice to make with hands-on workshops is whether to **walkthrough** the exercise with the students or to have students go through the steps **individually** (or in small groups). Miriam Posner [9] offers a compelling argument for the latter, including a description of the **Post-It note** method she uses to verify that students are on track. (To summarize, providing colored Post-It notes to students allows them to signal to the instructor three different possible states: things are going well (green), having trouble (red), finished with the exercise (white).)

Hands-on workshops, of course, have the added difficulty of ensuring that students all have access to the appropriate software. Depending on the audience, there may be participants using work laptops to which they do not have administrator rights. Focusing on common tools (e.g., Excel) or web-based tools (e.g., Plotly [8]) can mitigate some of the trouble, but many useful tools related to visualization do require installation. Using virtual machines that run in the browser (e.g., Frame [4], Amazon AppStream [1]) or services that create self-contained executables (e.g., Cameyo [2]) may offer alternatives.

For instruction that focuses less on a specific tool and more on a visualization or design concept, the challenge is to engage the audience within the limited time available. Developing an "eye" for visualization is a process that takes time and exposure to many examples and situations, involving both data and visual literacies. Short-form conceptual instruction may seem to lend itself to a lecture approach to cover as much material as possible, but even students who are excited to attend a workshop on visualization concepts will have trouble engaging with just a lecture.

Instead, it may be possible to use a **group critique** exercise to help students learn the concept more actively. Each individual may be new to some aspects of visualization, but a group discussion will leverage the aggregate expertise in the room. By showing a particular visualization in need of redesign, for example, each individual can be exposed to new viewpoints that teach them about new aspects of data visualization. Using **chart makeovers** [7,10] for these group discussions makes it easy to identify problems with charts and then quickly see how an expert might adjust the design of the chart to address those issues. While students won't get the hands-on experience of redesigning a chart themselves, it does help them go through the mental exercise of observing chart design decisions and speculating about other options. Simply showing examples does not force students to imagine the consequences of design decisions.

Some topics that seem conceptual, however, can be made to be hands on. For example, designing an infographic or poster involves many underlying concepts and can be difficult to convert into an activity appropriate for a short-form instruction session, but the ability to practice the process while the instructor is available to help can be extremely valuable for students. Preparing sample "data" (i.e., blocks of text, statistics, basic charts) that can easily be composed into an infographic may take the instructor additional time, but the students will benefit much more from an activity than a lecture.

4 Additional Considerations

While audience type and instructional focus both have a large effect on the design of a short-form instruction session, other considerations should also be taken into account.

4.1 Comprehensiveness

Short-form instruction cannot be comprehensive. Even long-form instruction cannot be comprehensive. Choices must be made to limit the instruction to a manageable amount. To help make these choices, the instructor should clarify a precise **learning objective** for the instruction session, and that objective should be clearly communicated in any descriptions or advertisements. With short-form instruction, there may be different learning objectives than those for a semester-long course. The reality of the short-form instruction is that there is a limit to how much of the visualization process can be taught in a short time. More constrained learning objectives, such as "help students learn how to Google Tableau problems" or "inspire students to take the time to enroll in a longer course," may suffice for some workshops.

As mentioned previously, if the session presumes some prior knowledge in a particular subject, that should be stated clearly, and any resources for acquiring that knowledge should also be distributed. Even so, it is important to spend some time "setting the stage" at the beginning of the session to make sure that the concepts that will be used in the session have been enumerated and defined for the students. Regardless of the scope of the workshop, try to structure the content such that individuals leave with a completed project and a sense of confidence about the process.

4.2 Fluid Attendance

Especially for sessions that are being offered for a general audience, you may not be able to rely on all students arriving at the beginning of the sessions and staying through to the end. If there is a link to the materials, it should be displayed prominently throughout the session. If there are handouts, try to find some way to signal at all times what step of the handout you are currently working on. For individuals who must leave early, make sure they have access to any evaluation form from the very beginning, and try to distribute all material at the beginning so they can complete remaining activities on their own (whenever possible).

4.3 Helpers

For large instruction sessions, especially those that are hands-on, it is good practice to have an assistant who can answer quick questions from the audience without completely interrupting the flow of the instruction session. Helpers can also distribute handouts, coordinate evaluations, collect contact information, facilitate question and answer sessions, etc.

4.4 Flipping the Classroom

For instruction sessions that focus on a very specific group of individuals, it may be possible to assign homework before the session. It is especially tempting to do this for short-form instruction sessions, as time is so limited within the session. This approach should be used with caution, however, and materials should be constructed so that they work both for those who have done the homework and for those who have not.

4.5 Sharing Materials

Materials for short-form instruction sessions may range from data and detailed steps for in-class activities, take-home reminder sheets for visualization concepts, links to other helpful tools or tutorials, resources for learning about related or more advanced topics, etc. When distributing instructions for hands-on sessions, printed handouts tend to make it much easier to see both the instructions and the software application at the same time. However, sessions using command line tools may benefit from digital copies of instructions, so the commands can be copied instead of typed. To offer persistent access to materials, open and stable services like GitHub [5] and Google Drive [6] have proven popular. Because some people prefer paper while others prefer digital, it may be easiest to generate a shared digital document that can also be printed. Digital documents also have the advantage of being easily distributed to interested parties who were unable to attend the workshop; recording a video and/or screencast of the workshop also aids in distribution after the fact.

4.6 Continued Study

Short-form instruction sessions may occur in such a way that students lose some access to the visualization expertise after the workshop concludes. For example, an individual employed by a university may attend a visualization workshop at a conference, but upon returning to his/her home institution, there may not be any resources for further study or consultation. In other situations, there may be some generalized help on visualization in a non-degree-granting unit of the university, such as the library or an IT organization. Individuals hoping to develop more in-depth expertise in visualization may not have access to faculty or semester-long courses in the area. Instructors of short-form visualization workshops would do well to compile, distribute, and maintain lists of **widely available resources** [12] for continued or advanced study – e.g., MOOCs, webinar series, textbooks, tutorials, etc. Lists of such materials are destined to stale quickly, but focusing on reputable platforms, stable tools, and established faculty may mitigate some of the risk of rapid expiration. By the same token, the broader visualization community benefits immensely when instructors of long-form courses go to the extra time and effort of creating and distributing education materials that go beyond a beginning level. The visualization literacy of the broader public will increase dramatically as more high-quality visualization instructional material becomes widely (and freely) distributed.

5 Conclusion

Most of the strategies for short-form data visualization instruction presented here have been tested in instruction sessions offered as part of the broader data visualization services provided by the Duke University Libraries [11]. Feedback on various types and sizes of workshops has overall been positive, but feedback seems especially strong when instruction focuses on active engagement with audience members and when there is a clear transition from workshop activities to personal projects. Nonetheless, there are still many challenges with short-form visualization pedagogy. The practice it takes to learn relevant software applications, combined with the necessary design instincts that can only be developed by practice and exposure, as well as the time required to craft a visualization make it a difficult activity to pursue in short bursts. To date, the most helpful information to include in a short-form instruction session has always been the instructor's personal email address and an invitation to stay in touch about specific questions and projects.

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