

DataViz and Data Storytelling Education in Journalism and Communication Programs

Masudul Biswas
Loyola University Maryland

Carrie Sipes
Shippensburg University of Pennsylvania

Abstract

This exploratory study used multiple methods – survey, document analysis, and interviews – to assess the state of data visualization and data storytelling education in U.S. communication and journalism programs. The findings reflect how various programs offer these courses, i.e., accredited vs. non-accredited programs, large vs. small programs. Results also show the topics and tools taught in these courses, how faculty assess students' learning outcomes, challenges course instructors encounter, and teaching strategies they find useful. Some of the key findings are: 1) not all accredited programs offer a stand-alone course on data storytelling; 2) more small programs, compared to large programs, require students to take the courses that teach DataViz as a topic/module; and 3) instructors follow two approaches to teaching a data storytelling course: a software or application-heavy approach or a comprehensive approach covering both concepts and applications.

Introduction

Using data to report and tell a story in a visual and digestible manner is essential for journalists and communication professionals (Berret & Phillips, 2016; Berinato, 2016). Data visualization skill is no longer a “nice-to-have” skill. Instead, it has become an essential visual communication skill for a communication professional (Berinato, 2016, para 1). Furthermore, the application of “basic numerical and statistical concepts is one of the Accrediting Council on Education in Journalism and Mass Communication's core competencies (ACEJMC, n.d.).” Therefore, journalism and communication programs are expected to

prepare students with numerical competency. But not all communication and journalism programs in the U.S. offered a stand-alone course on data storytelling. In 2015, about 52% of the accredited programs offered one or more courses on data storytelling (Berret & Phillips, 2016).

Communication and journalism programs are beginning to catch up on data literacy education (Berret & Phillips, 2016). Given the demand for this employable skill among a wide range of communication and journalism fields, it's likely that many more academic programs will be interested in launching a new course or module in data visualization or data storytelling.

Keywords: Data Journalism, Journalism Education, Data Visualization

This exploratory study on curriculum and teaching seeks to understand how data visualization and data storytelling is taught. The study examines topics and tools covered in the courses, assessments of learning outcomes, challenges the course instructors encounter, and teaching strategies they find effective.

Faculty can teach data visualization in the courses on DataViz and infographics and also in data storytelling or data journalism courses. Therefore, the scope of this study includes data visualization and related courses offered in journalism and communication programs, such as data storytelling. Hence, data visualization, data journalism, and data storytelling are used frequently in this manuscript.

Literature Review

Data Visualization and Data Journalism: Data reporting and data visualization are two key components of data storytelling. Berret and Phillips (2016) defined a data journalism course in the intersection of data and journalism where the course uses spreadsheets, statistical software, databases, and visualization and or data presentation software toward the end. Discussion on data visualization goes hand in hand with the discussion of data storytelling. The process of creating data visualization and data reporting in a story is very similar: 1) research data from finding data to understanding and interviewing data and 2) report data via text and visuals (IRE Admin, 2013; Berret & Phillips, 2016).

Data visualization is defined as “visualization of numeric values with charts, tables, and graphics and as transformation of raw data information to visual presentations” (Dur, 2014, p.41). Through these visualization formats, data visualization, also known as DataViz, serves three functions: to inform, persuade, and engage or entertain (Dur, 2014; Kennedy, Allen, Hill, Engebresten, Kirk & Weber, 2019). A well-designed interactive DataViz content can encourage the audience to engage and interact with data (Zote, 2020). By creating a clear and easy-to-understand visualization, journalists and communicators can convey messages about a complex set of data. In addition to information function, DataViz's purpose is to persuade the audience to take specific actions about an issue, such as environmental, social, and political. For example, visualization of data that shows the relationship between social distancing and flattening the curve of COVID-19 spread can encourage more people to realize the importance of social distancing and

adopt that lifestyle until the peak of the crisis is over. **Teaching Data Visualization and Data Storytelling:** There have been very few studies conducted on DataViz, data journalism curriculum, and teaching. Past research suggests that three broad topics – research, ethics, and design of information – are emphasized in the teaching of DataViz and data storytelling courses (Dur, 2014; Krum 2013; Cairo, 2012; Bennett & Vulpinari, 2011). Research is the first step and essential part of developing good data visualization (Dur, 2014). Data research involves identifying authoritative sources of data, understanding a data set and relationships between variables, and interviewing data to develop a story idea presented through text and visuals, such as charts, maps, and tables (IRE admin, 2013). Dur (2014, p.45) argued that data should be analyzed well (i.e., sorting and filtering) for the organization of content (i.e., cleaning and preparing a dataset for analysis) and for creating “meaningful structures” for data visualization.

Like objectivity and source attribution in news reporting, the data visualization and storytelling process needs to comply with ethical guidelines. Alberto Cairo (2019) argues that DataViz content, such as charts, can lie or advance misleading information by representing incomplete or inaccurate data. Therefore, data storytelling and visualization students must recognize a flawed dataset or identify a misleading data visualization. Other ethical considerations in information design and data storytelling include attributing the sources of data, respecting copyright in terms of usage of data and vector graphics associated with data, and not manipulating images (Pettersson, 2010). Because of some data's legal considerations, discussing data in the context of a media law and ethics course is also recommended (Berret & Phillips, 2016).

The final stage of the data storytelling process is the visualization part. Clarity of visualization, type or appropriateness of visualization format/structure, color consistency, quality of data, or story angle, creativity is generally used to evaluate infographics and other data visualization (Dur, 2014; Cairo, 2019; Pettersson, 2010). Data visualization lessons of ethics should also include respecting “human, environmental, and cultural diversity” through an inclusive design of information (Bennett & Vulpinari, 2011, p. 9). Audrey Bennett and Omar Vulpinari (2011) argue that students need to develop a sense of responsibility for their DataViz work and seek underrepresented populations' voices.

Course Offering Ideas: A 2015 Columbia Journalism School study on data storytelling education put forward recommendations for teaching data storytelling and data visualization. One recommendation was to incorporate data skills into a range of introductory, mid-level, and advanced courses (Berret & Phillips, 2016). For example, programs can integrate data skills into introductory video or multimedia courses where simple DataViz tools can be introduced. Berret and Phillips (2016) suggest other ideas for teaching data skills across the curriculum, such as integrating data into reporting, feature writing, social media analytics, and digital design courses.

Collaboration with other departments: The American Press Institute’s report on how to teach data reporting in journalism schools suggests partnering with other departments on campus, namely the computer science department (Sunne, 2016). Sunne (2016) argues that faculty need to show communication students that the need for data skills applies to them and that anyone can learn these skills. One strategy to address this is to create low stakes opportunities for engaging in data skill building projects or inviting computer science or data science professors to guest lecture in a class (Sunne, 2016).

The 2015 Columbia Journalism School study (Berret & Phillips, 2016) mainly examined the curricula of the ACEJMC-accredited programs. Still, its recommendations on integrating data skills into various communication and journalism courses apply to any journalism and communication program. Likewise, collaborating with other academic disciplines such as data science or computer science can help a program that does not have a resource or faculty to teach data storytelling and data visualization (Sunne, 2016). Unlike previous studies, this study sample includes accredited and non-accredited programs, large and small programs. It looks into both courses – dedicated courses on data storytelling or data visualization and those that incorporate DataViz or data storytelling as a topic or a module. This exploratory study will seek to understand the state of DataViz and data storytelling education in a variety of U.S. communication and journalism programs through the following research questions:

RQ1: What is the state of course offerings on DataViz or data journalism in communication and journalism programs in terms of accreditation status, i.e., ACEJMC-accredited *vs.* Non-accredited programs, and program size,

i.e., small *vs.* large program?

RQ2: What tools or software do students learn in the courses on DataViz or data journalism and the courses that incorporated DataViz as a topic/module?

RQ3: What are the topics covered about DataViz or data journalism when offered through a course or as a module of a course?

RQ4: What are the major assignments for assessing the learning outcomes in DataViz?

RQ5: What were the challenges in teaching a data storytelling or DataViz course, and what teaching strategies did instructors adopt to address those challenges?

Methods

This study used multiple methods – survey, document analysis, and follow-up interviews – to gather responses around the research questions. The purpose of using a mixed-methods approach in a study is to collect and analyze both quantitative and qualitative data that can sufficiently inform the research questions (Shorten & Smith, 2017). The use of mixed methods was necessary since research questions in this study sought to explore the *what* and *how* of DataViz or data storytelling curriculum. Surveys can yield quantitative and qualitative data since the survey questionnaire can include both quantitative and qualitative questions to reveal answers to what and how questions (Millikin, 2016). Document analysis, a systematic process of reviewing and analyzing documents, and interviews, a method to understand individual experiences, are qualitative research methods that deal with *why* and *how* questions (Bowen, 2009; Ratislavová & Ratislav, 2014).

Survey: An online survey, created with online survey tool Qualtrics, was conducted between January and March 2020. Questions gathered insights on course offerings on DataViz or related courses, such as Data Journalism, in U.S. communication and journalism programs. Survey items also collected information on the software/tools covered in these courses and the backgrounds of these programs, such as faculty size, student enrollment, accreditation status, public *vs.* private. Responses to these questions addressed RQ 1 and RQ 2. RQ 1 aims to identify which programs offer education on DataViz or data storytelling and how they offer such courses, i.e., dedicated course *vs.* a topic/module in another course, compulsory *vs.* elective course. RQ 2 intends to document the tools

or software used in DataViz and Data Storytelling courses.

Since this is an exploratory study, the link to the survey was distributed through multiple channels – contacting faculty individually and sharing the link to the survey through two listservs of a professional association representing communication and journalism educators. Response to the survey was voluntary and anonymous. Respondents were required to give their consent to participate in the survey. The survey initially received 30 responses. Later, researchers excluded three responses from the analysis. Two responses were excluded because they came from international universities. The other excluded response was an incomplete response from the same department from which this survey received a complete response. Therefore, the survey findings are based on 27 responses from 27 communication and journalism programs located in 25 universities – 11 in the South, five in the Midwest, five in the East, and four in the West. For two universities, this survey received multiple responses from separate communication disciplines. No departments submitted multiple responses. These universities are also largely public institutions. Twenty of them are public universities, and five are private universities.

Additionally, 13 of the 27 communication and journalism programs were ACEJMC-accredited. Furthermore, 14 of these programs were considered small programs since they reported less than 14 full-time faculty. Twelve programs were considered large programs because their reported faculty size was more than 14. The Annual Survey of Journalism & Mass Communication Enrollments used a faculty size of 14.4 as a break-point for a small program (Becker, Vlad, & Simpson, 2014).

Information gathering took place at a time when

the COVID-19 pandemic disrupted normal academic activities. Consequently, the survey did not receive a higher number of responses. Therefore, this study used document analysis and interview methods to gather rich information about data visualization and storytelling education and teaching in U.S. journalism and communication programs.

Document Analysis: Researchers conducted document analysis on 26 syllabi and eight assignment documents/prospectuses on DataViz and Data Storytelling projects used in 23 journalism and communication programs. Of these, 22 syllabi and six assignments were used in a dedicated course on data storytelling. There were multiple such courses taught in one program. Fifteen syllabi and eight assignment documents were gathered through survey responses from 13 programs. Eleven data journalism or related course syllabi used in 10 programs were gathered through Internet searches. The webpage on computer-assisted reporting and data syllabi of the Investigative Journalism Education Consortium’s website helped locate data storytelling syllabi used in U.S. journalism and communication programs. Syllabi and assignments considered for document analysis were used for teaching within the four years of this study, between 2016 - 2020.

The main reason for conducting a document analysis of syllabi and assignments was to inform the responses to RQ 2, RQ 3, and RQ 4. RQ 2 is concerned about the tools and software used in DataViz courses. Through RQ 3, this study seeks to understand the topics covered in a DataViz course. RQ 4 deals with types of assignments or proficiencies that demonstrate learning outcomes in a DataViz or data storytelling course.

Interviews: This study conducted follow-up inter-

TABLE 1: Teaching of DataViz in Curricula: Accredited vs. Non-Accredited, Large vs. Small Programs

	ACEJMC Accredited Programs (n = 13)	Non-Accredited Programs (n = 14)	Large Programs (n = 12)	Small Programs (n = 14)
Programs that teach DataViz in their curricula	12	8	10	10
Programs that do not teach DataViz in their curricula	1	6	2	4

Note: Data reported on this table are in frequency. One accredited program did not report its faculty size. Faculty size is used to determine whether a program is large or small in this study.

TABLE 2: How Programs Offer a Dedicated Course on DataViz/Data Journalism:
Accredited vs. Non-Accredited, Large vs. Small Programs

	ACEJMC Accredited Programs (n = 5)	Non-Accredited Programs (n = 3)	Large Programs (n = 5)	Small Programs (n = 3)
Compulsory for all majors or sequences in the program	0	1	0	1
Compulsory for selected or some sequences/majors in the program	1	1	1	1
Elective Course	4	1	4	1

Note: Not all programs that teach DataViz in their curricula reported this information.

views to gain insights on how faculty teach ethics and design principles in DataViz and data journalism courses. Questions also included effective teaching strategies and what interviewees found challenging. Follow-up interviews gathered information related to RQ 3, which seeks to know the topics covered in DataViz or data journalism courses. These interviews also informed RQ 5, identifying challenges and effective strategies in teaching DataViz or data storytelling.

Researchers sent interview requests with follow-up questions via email to eight survey respondents/faculty representing four large and four small programs between February – May 2020. The sample size for interviews may range from six to 20 depending on the topic and the techniques used in gathering rich data (Morse, 1994; Creswell, 1998; Schensul, 2011; Tracy, 2012). Seven faculty members responded to interview questions via email and over the phone.

Findings

RQ1: What was the state of course offerings on DataViz or data journalism in communication and journalism programs regarding accreditation status, i.e., ACEJMC-accredited vs. Non-accredited programs, and program size, i.e., small vs. large program?

Of the responses that we received from 27 programs, 20 programs offer a course on data visualization or teach data visualization as a topic/module. It means that most of the programs from which we received responses to our survey (about 74 percent of the survey respondents) teach DataViz in their curricula (Table 1).

Of the 13 ACEJMC-accredited programs that responded to this survey, 12 programs (92% of the respondents) offered a course on DataViz or data journalism or taught DataViz as a topic/module of a course. Only one accredited program reported that they do not teach DataViz in their curriculum. Of the 14 non-accredited programs, eight programs reported that they offer a course on DataViz or data journalism or teach DataViz as a topic/module. In comparison, six such programs said they did not provide such a course (Table 1).

Of the 12 large programs, in terms of faculty size, that responded to this survey, only two programs reported that they neither offered a course on DataViz or data journalism nor incorporated those topics/skills into other classes in their curricula. Two large programs that did not teach DataViz were non-accredited. But a majority of the large program respondents (87 percent) reported that they taught DataViz in their curricula. Similarly, most of the small program respondents (71 percent) said that they taught DataViz in their curricula, while only four such programs reported that they did not teach DataViz in their curricula (Table 1).

Of the 12 accredited programs that offered DataViz education in their curricula, eight were large programs, and four were small programs. Among the non-accredited programs that taught DataViz in their curricula, two were large programs, and six were small programs. In contrast, four non-accredited small programs, two non-accredited large programs, and one

accredited large program reported that they did not teach DataViz or data storytelling in their curricula (Table 1).

Course Type and Nature of Course Offerings: A total of eight programs – five accredited and three non-accredited – reported that they offered a course on DataViz or Data Journalism (Table 2). Twelve other programs – seven accredited and five non-accredited – said that they incorporated DataViz as a topic or a module in another course in the curricula (Table 3). Four of these programs, three accredited and one non-accredited program, offer both a course on DataViz and a course that incorporates DataViz as a topic/module. For example, a program provides data journalism that fully focused on DataViz and data storytelling, while the same program's additional course – digital communication – incorporates a module on DataViz.

Names of dedicated courses on DataViz that these programs offered were: Data journalism, Data for Media, Media Analytics and Data Visualization, Sports Data Analysis and Visualization, Big Data, Data Visualization, and Mapping, Introduction to infographics and data visualization, Advanced-Data Visualization.

Of the programs that offered a dedicated course on data journalism or data visualization, most of them offered it as an elective course. It was compulsory or required for all majors in only one program: a small, ACEJMC non-accredited program. One accredited and one non-accredited program reported require-

ments for DataViz or data journalism courses for some majors/specializations (Table 2).

By program/faculty size, five large programs and three small programs offered a course on DataViz or data journalism. Of these programs, two small programs and one large program required all or some of its majors to take a DataViz or data journalism course. Four large programs and one small program offered such courses as electives to any of its majors (Table 2).

More programs (six) reported that their courses incorporated DataViz as a topic or module were compulsory for all majors or sequences in the school/department. Of these six programs, three were accredited programs and three were non-accredited programs; and only one of these programs was a large program (Table 3). Six programs that incorporated DataViz as a topic in a course offered such courses as an elective to any department major. Of these six programs, four were accredited, and two were non-accredited programs; similarly, four were large programs, and two were small programs (Table 3).

Names of the courses that incorporated DataViz as a topic or a module were: digital media tools, digital media skills, multimedia storytelling, Spanish-Language news media, selected topics in new media, advanced-level web design, digital communication, and an advanced editing capstone seminar in multimedia reporting.

While offering a course on data journalism or DataViz, only one program reported that they partnered with another department. Students in a

TABLE 3: How Programs offer a Course That Incorporates DataViz as a Topic/Module:
Accredited vs. Non-Accredited, Large vs. Small Programs

	ACEJMC Accredited Programs (n=7)	Non-Accredited Programs (n = 5)	Large Programs (n=5)	Small Programs (n=7)
Compulsory for all majors/sequences in the program	3	3	1	5
Compulsory for selected/ some sequences/majors in the program	0	0	0	0
Elective Course	4	2	4	2

Note: Not all programs that teach DataViz in their curricula reported this information.

TABLE 4: Tools and Software Used in Teaching Data Storytelling

5 Top DataViz Software in Teaching Data Storytelling	Major Functions	Costs
Tableau	Creating interactive charts and maps with data	Tableau Public is Free. Tableau Desktop is also free through education license for students and instructors.
Microsoft Excel	Preparing and cleaning dataset	Part of Microsoft Office
Google Studio	Cleaning dataset and creating charts	Free.
Datawrapper	Creating interactive charts and maps with data	Free version is good for educational purposes.
R Studio	Creating interactive charts and maps with data (coding skill is required)	Desktop version is free and good for educational use.
Other DataViz software used in teaching data storytelling	Major Functions	Costs
Flourish	Creating interactive charts and maps	Free version is good for educational use.
iNZight	Data cleaning and exploration	Free and open-source.
BatchGeo Pro	Creating maps	99 dollars/month.
ArcGIS Personal/Student Use	Creating maps	100 dollars/year.
QGIS	Exploring data; creating, editing and managing data; publishing maps	Free and Open-Source.
Infogram	Creating interactive charts, maps and infographics	Free for students and educators under education license.
D3.js	Creating interactive charts and maps (JavaScript/coding skill is required)	Free and open-source.
Storyline.js	Creating annotated and interactive line charts	Free and open-source.
Canva	Creating infographics	Free version can be limiting. Pro version is 12.95/month for up to 5 users.

Note: Cost information was not part of this survey and this information may change. Researchers gathered cost information from the respective software's website. Readers who are not familiar with these tools and are interested to make a decision on a DataViz software for their classes will find cost information useful.

non-accredited communication program could take GIS courses from the geography department.

RQ2: What tools or software did students learn in the courses on DataViz or data journalism and the courses that incorporated DataViz as a topic/module?

From the survey responses as well as document analysis, the top five most-used DataViz software in stand-alone DataViz and topic/module-based DataViz courses include Tableau (18) for creating charts and maps with data; Microsoft Excel (14) for preparing and cleaning data set; Google tools such as Google Data Studio, Google Maps and Google Sheets (9) for cleaning data and creating charts; Datawrapper (5) for creating charts and maps, and R or R Studio (4) for creating charts and maps (Table 4).

A dedicated course on DataViz/data journalism tends to use multiple DataViz software, while courses covering DataViz as a topic usually stick to one or a maximum of two software. For example, a course instructor of an infographic and visualization course reported using multiple tools. The instructor used Excel for sorting and preparing spreadsheets, Illustrator for styling visualization and creating vector graphics, Flourish, data-illustrator.com, and the R-Studio for creating various types of charts, tables, and maps. On the contrary, a web design course that covered DataViz as a course topic used Datawrapper as a DataViz software.

Other DataViz software used in DataViz courses includes Flourish for creating charts and maps, INZight for data cleaning and exploration, Python for data visualization, d3.js, and Storyline.js for creating interactive charts. Instructors used BatchGeo and ArcGIS for creating maps, Tabula for extracting data from PDF, and QGIS for visualizing geographic data. Additional software such as Illustrator was used to create vector graphics in infographics and modify data visualization for print outlets. Faculty also used Canva for infographics and Infogram for charts. Some of the software mentioned above requires some coding skills. Usually, advanced-level data visualization courses adopt coding-intensive approaches to data visualization (Table 4).

RQ3: What were the topics covered about DataViz or data journalism when it is offered through a course or as a module of a course? Since this study analyzed syllabi of both DataViz/

data storytelling courses and DataViz as a course topic/module, the findings on course topics are reported separately by course type.

DataViz and Data Storytelling Courses: After reviewing 22 syllabi on DataViz courses from 19 programs, two approaches to teaching DataViz were identified. *One method* is to design course lessons heavily around DataViz software applications. A DataViz course that utilizes DataViz software, such as the R or R studio, usually spends the whole or a majority of the semester around various applications of this versatile DataViz application. For example, in such a DataViz application-heavy course, students learn to create single-variable charts, multiple-variable charts, maps, GIS such as cartography. The R requires learning some coding or programming language. Another course that also teaches students how to create an interactive data visualization with coding dedicates a part of the semester to “Coding for journalists – Basic HTML, CSS and JS” and some advanced HTML. Courses with software-heavy approaches also include “understanding visual presentation of qualitative and quantitative data” so that students can determine the appropriateness of using visualization in the context of various types of data.

Another approach instructors take is to begin the semester with discussions on DataViz design or visual storytelling principles. In this approach, instructors cover the concept of data literacy (i.e., how to read/understand data, how to interview data), how to find and use authoritative sources of data online, how to access public records and types of data, and variables. Instructors also discuss how to develop ideas for data-driven stories, how to ethically clean data, and prepare for data presentation phases before diving into the use of data visualization software. A course syllabus that reflects the latter approach included this statement as course objectives, “Think critically and deeply about the limitations of datasets and evaluate the strengths and weaknesses of data” and “Assess how institutions may be collecting and using data and the implications of these processes for the public.” In another course, the instructor primarily focuses on examining data for outliers and teaches students how to analyze and assess a dataset with outliers. By doing this, students also learn another ethical aspect associated with data literacy. A data-driven reporting course began the semester with “data journalism workflow and design.”

In both approaches, students are expected to learn the functions of various types of charts, use of

spreadsheets and tables, and maps. Students also learn functions of visualization elements, such as color and shapes, to make a correct decision on how to select an appropriate visualization format and style for a dataset.

In addition to learning how to prepare a dataset for appropriate data visualization and how to create charts and maps, students learn how to format and distribute DataViz content. Students learn to distribute content through video, print, and websites and how to write stories with data in these courses.

Courses that teach DataViz as a topic/module usually spend a week or two on this topic. In such a short period, courses introduce DataViz's use and concept in communication or journalism and engage in an activity to offer an essential skillset on data storytelling. As stated earlier in the findings to RQ3, such courses use relatively easy-to-use DataViz applications/tools such as Datawrapper, Google Sheets, Google Data Studio, Tableau Public, Storyline.JS.

In follow-up email responses to the survey, four instructors who incorporate DataViz as a topic/module in their courses explained how they address DataViz design principles and ethical issues in one-week or two-week modules. An instructor covered ethics while referring to data manipulation in the introduction of DataViz. Students in his class implement DataViz design principles through completing a lab/class activity. Another faculty discussed the ethics of using personal data such as Social Security numbers that can be readily available in public records. Halfway through the semester, she discussed the Society of Professional Journalists' *Code of Ethics*. Another faculty responded, "The discussion of ethics is implied when we learn how to prepare data and how to tell a story with data. We also discuss which charts can present data more accurately." Another response to incorporating design principle is, "In my rubric for DataViz assignments, I include criteria for implementing DataViz principles since students can implement principles of DataViz through data labels, color and texture, the title of a chart/map, and accessibility."

Demonstration of numeric and data literacy is one of the accreditation standards of the ACEJMC. In one ACEJMC-accredited program syllabus, we noticed that a program could achieve the ACEJMC values and competency through a DataViz or data story assignment. As stated in the syllabus, ACEJMC values and competency for student learning that could be relevant to a DataViz assignment is a) the application of basic numerical and statistical concepts and b)

understanding concepts and application of theories in the presentation of images and information.

RQ4: What were the major assignments for assessing the learning outcomes in DataViz?

Assignment analysis on 26 syllabi and eight assignment prospectuses on DataViz show clear distinctions in assessing learning outcomes between the instructors teaching a course on DataViz or data journalism and those incorporating DataViz as a topic/module. A course on DataViz or data journalism allows students to spend more time learning the DataViz concepts and associated applications/tools. In these courses, students work through multiple projects and homework assignments. In contrast, in a class that incorporates data storytelling as a topic, students spend a week or two to learn the process of DataViz creation and then work on an activity to create DataViz content or a data-driven story. In semester-long DataViz courses, instructors tend to assign numerous homework assignments that reinforce classroom learning and readings. For example, an instructor in a sports data analysis course gave students about 30 short assignments. Each of these assignments is based on each lesson in the class, mostly on DataViz software, R. Below, highlights of DataViz assignments are organized by two types – courses on DataViz or data journalism and courses that incorporate DataViz or data storytelling as a topic/module.

DataViz assignments in courses that incorporate DataViz as a topic/module: A typical assignment for a module on DataViz requires students to create a clear, meaningful, and accurate visualization in either a chart or a map using raw data or a dataset gathered from a public data source. Additionally, instructors ask students to refine and sort the data to have the dataset prepared for visualization in such assignments. An instructor of multimedia storytelling class allocated 10 percent of course grades for a data storytelling project.

Analysis of assignment prospectuses revealed some variations of the above-mentioned typical assignment. For example, a course instructor designed a week-long multipart activity on DataViz that guided students in collecting data through multiple methods and scraping data from a webpage, a PDF document, and a dataset from an online data portal. The activity also included lessons on creating a data-appropriate visualization with Datawrapper and how to embed an interactive chart or a map into a WordPress page. In another course, students created a data-driven visual

story optimized for a smartphone with multiple DataViz content – "5 tables, charts, or maps of 3 different types." The course that spent two weeks on DataViz created opportunities for students to experience Tableau and Datawrapper through two homework assignments and one major project. Students created charts and maps based on a public data source, e.g. U.S. Census data, United Nations data, or Pew Research Center data.

DataViz Assignments in DataViz-specific courses: DataViz or data journalism courses can be demanding in terms of expectations outlined for various assignments. Students often create multiple charts and maps for a data story. Generally, students work on a serious public policy topic unless the course focuses on a particular area or beat, such as sports. Short descriptions of selected assignments in DataViz and Data Journalism courses are listed below:

- Students write a headline that accurately summarizes the story "and would encourage sharing on social media," the story that "provides proper context for the charts, credits the source, and follows grammar rules." Also, students include multiple charts with proper style and data labels.
- Students at a large research university in Southwest/South create a DataViz dashboard with a map and related charts using Tableau. While creating a visualization, students clean or prepare the data for visualization.
- In another course, students create two blog posts with visualizations on a topic of their choosing during a semester. For those assignments, students need to write a "completely documented R Notebook," explaining what they did and why. In addition to writing a notebook and creating a "publicly-facing" (accessible to the public) post with appropriate data visualization, students make a 5-minute presentation about their project.
- A course on advanced reporting that mainly focuses on data visualization included these assignments – Twitter data analysis with R and text mining with R.
- A group project in a data journalism course: Each team of four students produces a story with approximately 1,000 words (including the main story and any sidebars) on a topic of hospital data, campus crime, beach water quality, youth issues, education, poverty, hunger, alternative energy, and real estate values. Additionally, as a solution journalism lesson, students are asked to include

a data-driven solution to a problem in their story. The instructor required students to submit the electronic copies of spreadsheets as assignment deliverables. During the presentation, students briefly explain charts/graphics/other data visualizations used in the story.

- A final exam, worth 20 percent of the course grade, assesses the skills students have mastered during the semester. The exam consists of five essay questions and is very similar to the types of material a student analyzes during in-class exercises. For each question, students will be given a database and asked to find story ideas in it and examples of sources to interview for those stories.
- Students work on two interrelated projects in the "Telling Stories with Data" course. Both projects are worth 45% of the course grade. In the first project, students need to identify and acquire a local/state agency database to generate data-driven stories for follow-up class projects. For this assignment, students also need to write a report explaining their rationale for selecting that database. In a follow-up project, students need to analyze the database they have chosen in a 3 to 5-page report to demonstrate their learning outcomes on exploring a database for potential data stories.

RQ5: What were the challenges in teaching a data storytelling or DataViz course, and what teaching strategies did instructors adopt to address those challenges?

According to seven faculty interviewed for this study, three significant challenges of teaching data storytelling courses are: 1) lack of knowledge in spreadsheets and basic statistics among communication and journalism students, 2) lack of familiarity with introductory-level programming language among students, and 3) finding a low-cost but reproducible technology for DataViz creation.

Getting students to read tutorial instruction and having them follow the DataViz software tutorial steps is challenging for an instructor who incorporates multiple DataViz modules in his senior-level digital tools course. Therefore, to address this challenge, the instructor found the following approach helpful: "You cannot just show tutorials. You need to lead through a hands-on demo and share [a] sample project or two. And, you have to give time in [classroom] for the students to work on the project with you present to

troubleshoot.”

Six faculty observed that students’ lack of experience and knowledge with spreadsheets, such as Excel or Google Sheets, can be a significant challenge in teaching DataViz or a data journalism course. Therefore, one program is considering offering a separate mini-course on how to use Excel and related skills. An instructor commented that “[s]tudents seem to enjoy the creative part with Datawrapper and Tableau. But preparing or cleaning the data was challenging for some since some students did not have a strong statistics background.”

In addition to going over basic math at the beginning of the class, an instructor at a Midwest journalism program assigns “an extra credit assignment where they [students] listen to a podcast critical of high school math curricula.” To address the lack of preparedness for a math-oriented, coding-intensive DataViz class, the same faculty has developed a strategy “that’s built around lots of small assignments that build on each other. Students are coding multiple times a week and all of those assignments add up to a large part of their grade.” Another faculty at a Southern university assigns his students basic Excel tutorials available on Investigative Reporters & Editors (IRE) and LinkedIn Learning.

A faculty who incorporates DataViz into a senior capstone course argued that teaching materials on DataViz and software tutorials could be “complicated” to follow and learn. Students with no or inadequate experience of working with spreadsheets can find a long spreadsheet intimidating initially. Therefore, the instructor looks for “ground level ways to get students warmed up with simple, free tools and basic raw data sets that aren’t thousands of cells large.” Additionally, the instructor spends a fair amount of time commenting on students’ data viz drafts since students are new to DataViz, and [they] “need help gauging how many years of data to use, what chart or data viz type is best to use, how to work in colors, etc.”

Given that many students may not have much experience in using spreadsheets, an instructor of another course begins DataViz lessons with some simple visualization exercises because it’s essential for students to learn basic skills well. To address journalism students’ fear in a programming language, such as R, another faculty in his course on data journalism goes easy on students’ mistakes and offers students multiple attempts on an assignment to correct errors. In his class, students also complete each DataViz

technique through an iterative process. Students first learn a new approach to chart creation through a class activity in such an iterative process. They repeat the same approach in a subsequent homework activity, and in the end, they reflect on their learning through a project. In all phases, students receive feedback from the professor. Two DataViz instructors, who adopted such iterative approaches to learning, admitted that it requires a lot of time commitment. An instructor, who uses the collaboration tool Slack to resolve any software questions or coding errors for students, commented, “the advantage to this [iterative approach] is students get a lot of regular practice. They are never more than a day or two away from having coded last. They get lots of repetitions. The disadvantages to this are it creates an enormous amount of grading for me, and it usually means I’m interacting with four or five students online a day.”

Another challenge of teaching data journalism or a DataViz class is to find a low-cost tool/software that students can keep using after graduation for their professional work. That is why even knowing the fact that communication and journalism students generally are not well prepared to learn and use a programming language for creating DataViz, some faculty are teaching tools such as R. An instructor who teaches R in his data journalism course commented that since newsrooms have a limited budget for expensive proprietary software, which can be easy to use, it is important that students get training on open-source, free software, such as R, which can be difficult to learn.

One faculty found the “flipped classroom” strategy helpful for addressing the needs of students. Posting tutorials online and having students complete them before coming to a class allows the professor help students with multiple skill levels. Professors can work with a group of struggling students while high performing students can work on a different or additional activity.

Conclusions

Broadly, this study has two types of findings. One is about course offerings, and another is about pedagogical or teaching approaches. Given the sample size, the results related to course offerings are not generalizable. Within this sample’s scope, more accredited programs than non-accredited programs offered DataViz education either through a stand-alone course or through an existing course. Similar to a study finding by Charles Berret and Cheryl Phillips

(2016), not all accredited programs were offering a stand-alone course on DataViz or data storytelling. Instead, faculty integrated such data skills into existing introductory or advanced-level courses. Among these programs, more small-sized programs, compared to large programs, required students to take the courses that teach DataViz as a topic/module. One could argue that small programs with fewer faculty may not have the flexibility to offer a stand-alone course on data journalism. Still, they can integrate this essential skill into an existing communication and journalism course.

Twenty-six percent of the programs that responded to the survey reported that they did not offer DataViz education in their curricula. The programs that did not provide a course on DataViz or integrate data storytelling into an existing course can plan to introduce data skills instruction in their curricula or, as Sunne (2016) suggested, collaborate with another academic discipline, such as computer or data science.

Findings related to pedagogy can offer practical insights to communication and journalism faculty who want to create a new course on data storytelling or integrate it as a topic or a module in their existing courses. The study provides a starting place for DataViz topics and applications, assignment design, assessment of students’ learning outcomes, and strategies to counter challenges in teaching DataViz and data storytelling courses.

A previous study offered recommendations for integrating DataViz teaching in existing communication courses such as reporting courses, feature writing courses, and digital design courses (Berret & Phillips, 2016). This study found that more programs were teaching data skills through an existing communication and journalism course than offering stand-alone courses on DataViz or data storytelling. Some of the current communication and journalism courses that incorporated data storytelling or DataViz as a topic were multimedia storytelling, web design, capstone seminar in multimedia reporting, digital tools, and digital media skills.

Unlike the previous research, this study analyzed the syllabi and assignments used in those courses to gain deeper insights into how a course on DataViz or data storytelling is designed, how students’ learning outcomes are assessed, and what teaching strategies worked for faculty teaching such courses. Researchers identified two approaches in teaching stand-alone DataViz and data storytelling courses – a software or

application-heavy approach and a comprehensive approach of teaching essential concepts of data literacy, ethics in data storytelling and visualization, reporting data, and applications of data visualization. In both approaches, students learn the functions of various types of visualizations and how to research data to organize a dataset correctly to create an appropriate visualization. It was not clear how instructors who adopted the application-heavy approach to teaching DataViz addressed ethical aspects of data reporting and presentation.

In contrast, courses that integrated data skills into existing courses could not cover the discussion on the functions of various types of DataViz and data storytelling. Since ethics is an essential component in DataViz’s teaching (Cairo, 2019), this study sought to know through follow-up email interviews how faculty address ethical issues in the existing courses that integrated data visualization or data storytelling as a topic. Faculty included discussing ethics related to data in a general debate about media ethics or a code of ethics for journalism or explained the risk of data manipulation while working on a class activity with a dataset.

Writing and reporting skills have always been regarded as essential skills for communication and journalism students. Assignment prospectuses reviewed for this study reflected how faculty wanted to incorporate writing or reporting components and the DataViz presentation. For example, in several courses, students were asked to write a blog post or report for a website. In addition to writing, students created multiple charts and maps based on their findings from multiple datasets. In almost all cases, students demonstrated data research and data reporting skills, including visualization, through major assignments on DataViz or data storytelling.

The common challenge that journalism and communication faculty encountered in teaching DataViz and data storytelling courses is students’ lack of experience working with spreadsheets and programming language. Therefore, a couple of programs reported that they were planning to create a separate class or a mini-course on data skills. The mini-course goal is to help students gain proficiency with spreadsheets and basic statistics, which can be required before taking a storytelling or a data visualization course. Alternatively, instead of exposing complex and long datasets to students, some faculty just focused on simple and shorter datasets to develop the fundamental skills with DataViz and data storytelling. This teaching ap-

proach aligns with one of Berret and Phillips (2016) recommendations that journalism schools integrate data skills at various levels of courses. Therefore, if an introductory-level of storytelling or design courses can focus on the basics of DataViz or data storytelling skills, an advanced-level course can teach more advanced-level DataViz applications to deal with a complex set of multidimensional data.

Limitations and Further Research: The survey sample size is the main limitation of this study. But for an exploratory study, responses from 27 communication and journalism programs, analysis of 34 course materials, i.e., syllabi and assignment prospectuses, and seven follow-up interviews with the survey respondents offered important information. The study revealed topics taught in DataViz or data storytelling courses, assignment ideas, course materials such as software, and teaching strategies that can be useful for communication and journalism faculty. An expansion of this research will consider interviewing more faculty who teach DataViz and data storytelling courses to document their effective teaching strategies and provide a roadmap for offering data skills in the curriculum. These strategies would be beneficial since many journalism and communication students may not have enough experience working with spreadsheets and statistics.

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- Dr. Masudul Biswas conducts research in the areas of journalism and communication education, media and diversity, social media, and global media. In teaching, his specializations are web development, mobile design, user experience, digital content creation and storytelling, impacts of emerging media, and diversity and the media. Biswas has been teaching as a full-time communication faculty for the past 9 years. Email: mkbiswas@loyola.edu
- Dr. Carrie Sipes (casipes@ship.edu) is a professor of public relations and strategic communication. She teaches courses in public relations research, writing, ethics, theory, advertising copywriting, public relations foundations and strategy. She has worked in public relations and has been an educator for the past 15 years.

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