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Interactive Transcription Techniques for Interaction Analysis

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Abstract: Interaction analysis is a valuable method and approach to study knowledge in use in the learning sciences and CSCL communities. Central to interaction analysis is the creation of transcripts to selectively encode and represent audio and video data. However, current transcription techniques used in interaction analysis, including multimodal transcription techniques, have yet to explore the strengths and weaknesses of interactive visualization to selectively encode and represent people's interaction in context. Drawing from our recent efforts to amplify, not automate, transcription in qualitative research, this paper interactively visualizes one video dataset in five different ways using contemporary interactive visualization techniques. Findings and discussion characterize these visualizations as interactive transcripts that demonstrate techniques valuable to interaction analysis, but also highlight the need to expand how people, things, and context are represented through visualization mediums such as visualization programming languages to align with work more meaningfully in the learning sciences and CSCL communities.

Introduction

Interaction analysis is a valuable method and approach to study knowledge in use in the Learning Sciences and CSCL communities (Jordan & Henderson, 1995; also see Hall & Stevens, 2015). Interaction analysis relies on detailed analyses of audiovisual data to characterize interaction in ways that support analyses of learning or teaching, often from sociocultural or social practice perspectives. Central to interaction analysis is the creation of transcripts, which selectively encode and represent audio and video data to understand events from the perspective of participants and everyday people. However, current transcription techniques used in interaction analysis, including multimodal transcription techniques, derive primarily from the use of tools such as Microsoft Word or PowerPoint and have yet to explore the strengths and weaknesses of interactive visualization to selectively encode and represent people's interaction in context.

Drawing from our recent efforts to amplify, not automate, transcription in qualitative research, this paper interactively visualizes one qualitative, video dataset in five different ways using contemporary interactive visualization techniques. Findings and discussion characterize these visualizations as interactive transcripts that demonstrate techniques valuable to interaction analysis, but also highlight the need to expand how people, things, and context are represented through visualization mediums such as visualization programming languages to align with learning sciences and CSCL research, including recent efforts to expand the methodological commitments of interaction analysis (see Krishnamoorthy et al., 2021; Marin et al., 2020; Silvis et al., 2022).

We begin by reviewing relevant work concerning transcription and interaction analysis as well as relevant visualization theories. Subsequently, we describe the video dataset we analyze in this paper. We then describe five different interactive visualizations of this dataset by unpacking the techniques, encoding decisions, and insights made visible in each visualization. These visualizations are web-based, open source, and made available in this paper. Findings and discussion summarize the contributions of these visualizations as interactive transcription techniques for interaction analysis but also highlight the need to expand how people, things, and context are represented through visualization mediums in future research.

Theoretical framework

Transcription and interaction analysis

Transcription is used to encode and translate various forms of unstructured data such as audio or video into a representation that aids in interpreting unstructured data (see Atkinson & Heritage, 1999; Erickson, 2004; Duranti, 2007; Jefferson, 1984; Gee, 1999; Goodwin, 1994; Hall & Stevens, 2015; Mondada, 2007). For learning sciences and CSCL researchers who use interaction analysis, transcription is central to selectively representing sequences of interaction in order to study learning or teaching (for recent examples see DeLiema, Enyedy & Danish, 2017; Keifert & Stevens, 2019; Kelton, 2021; Hennessy Elliott et al., 2020; Ma & Munter, 2014; Marin, 2020; Jung et al., 2020; Steier, 2014; Taylor, 2017; Vossoughi et al., 2020). Notably, transcription is viewed as a theory laden and selective practice of encoding data (Ochs, 1979; also see Hall, 2000; Derry et al., 2010). This means that any transcription method encodes and represents data in ways that are reflective of the assumptions, biases, and goals

of the researcher (or computer) doing the transcribing. Likewise, qualitative researchers highlight the value of manual transcription (Lapadat & Lindsay, 1999; Erickson, 2004). While manual transcription is slow and tedious, the process provides ways to understand qualitative data that are fundamentally different than automated techniques emerging in fields such as computer vision and machine learning.

While transcription has evolved in many ways over the years, the mediums and tools used to produce transcripts have not changed considerably. Apart from a few novel examples (see Angus et al., 2012; Shapiro, Hall & Owens, 2017), transcripts are typically produced with language-based tools such as Microsoft Word and PowerPoint that support static and typically text-focused transcripts. This is the case even as transcription has rapidly expanded in innovative ways from a focus only on language to multimodality (Bezemer & Mavers, 2011; Kress & van Leeuwen, 2006), with multimodal transcripts often using the same tools to characterize phenomena such as gesture. Put simply, while researchers continue to highlight how these tools are inadequate to characterize the complexity and layeredness inherent to studying interaction in settings such as classrooms, the potential strengths and weaknesses of interactive visualization to address some of these limitations remains unexplored.

Alternative visualization theories and integrative visualization

In response to broader arguments about how visualization can more meaningfully and intimately represent and communicate with people and communities, new theories of visualization have emerged that focus on alternative ways of knowing, non-binary approaches to data, and the contextual dimensions of data (e.g., D'Ignazio & Klein, 2016; Lupi, 2017). This paper draws from our developing efforts to connect these theories with qualitative research through the notion integrative visualization (Shapiro, 2019).

As we describe in prior work, integrative visualization is a human-centered process to interpret unstructured data such as audio or video typical of qualitative research in ways that support the development of grounded theory (Glaser & Strauss, 1967) and contextual computational tools. A key part of integrative visualization is the use of visualization mediums such as graphics editors or programming languages to support manual and iterative transcription of data collected in context. Such transcription amplified by visualization aims to further the grounded theory process (e.g., generation of categories, codes, units of analysis and questions) and lead to insights that can inform the development of contextual computational tools. Notably, integrative visualization extends the practice of “integrative diagramming” (Strauss, 1987) as used by qualitative researchers and is summarized as follows:

data context → transcription amplified by visualization → grounded theory & computational tools

This paper contributes to a deeper understanding about the strengths and weaknesses of visualization mediums such as graphics editors and programming languages to amplify manual transcription, specifically for interaction analysis as used in the learning sciences and CSCL communities.

Data sources

Our subsequent analysis draws from a video from a bilingual elementary classroom. This 2-minute video of classroom interaction shows the teaching of a key idea in the physics of matter—that matter occupies space—in a kindergarten–first grade classroom and is available at the following link: https://youtu.be/d8_pRUR-hmg. In the video, a teacher is seated with her students around her on the floor of a classroom and conducts a brief experiment involving a jar and marbles to illustrate how matter occupies space. The teacher also facilitates a discussion about the experiment with the class. This dataset was chosen because it was collected by and is well known to researchers who use interaction analysis in the learning sciences and CSCL communities. Notably, this video was central to a recent conference supported by the Spencer Foundation at Arizona State University where an interdisciplinary group of older and younger scholars gathered to document the basic patterns of visual and auditory attention employed by researchers who use video to study social interaction (Erickson et al., 2017: see: <https://www.learninghowtolookandlisten.com>).

Analysis

Our analysis uses an established visualization programming language called D3.js to interactively visualize this dataset in five ways. Figure 1 shows a static image of each of these five visualizations along with a screenshot from the video dataset introduced previously. Interactive visualizations of each of these images are open source and can be explored at the following link, and we encourage readers to explore each interactive visualization while reading our subsequent analysis: <https://mrmathur.github.io/mos-visualizations/>

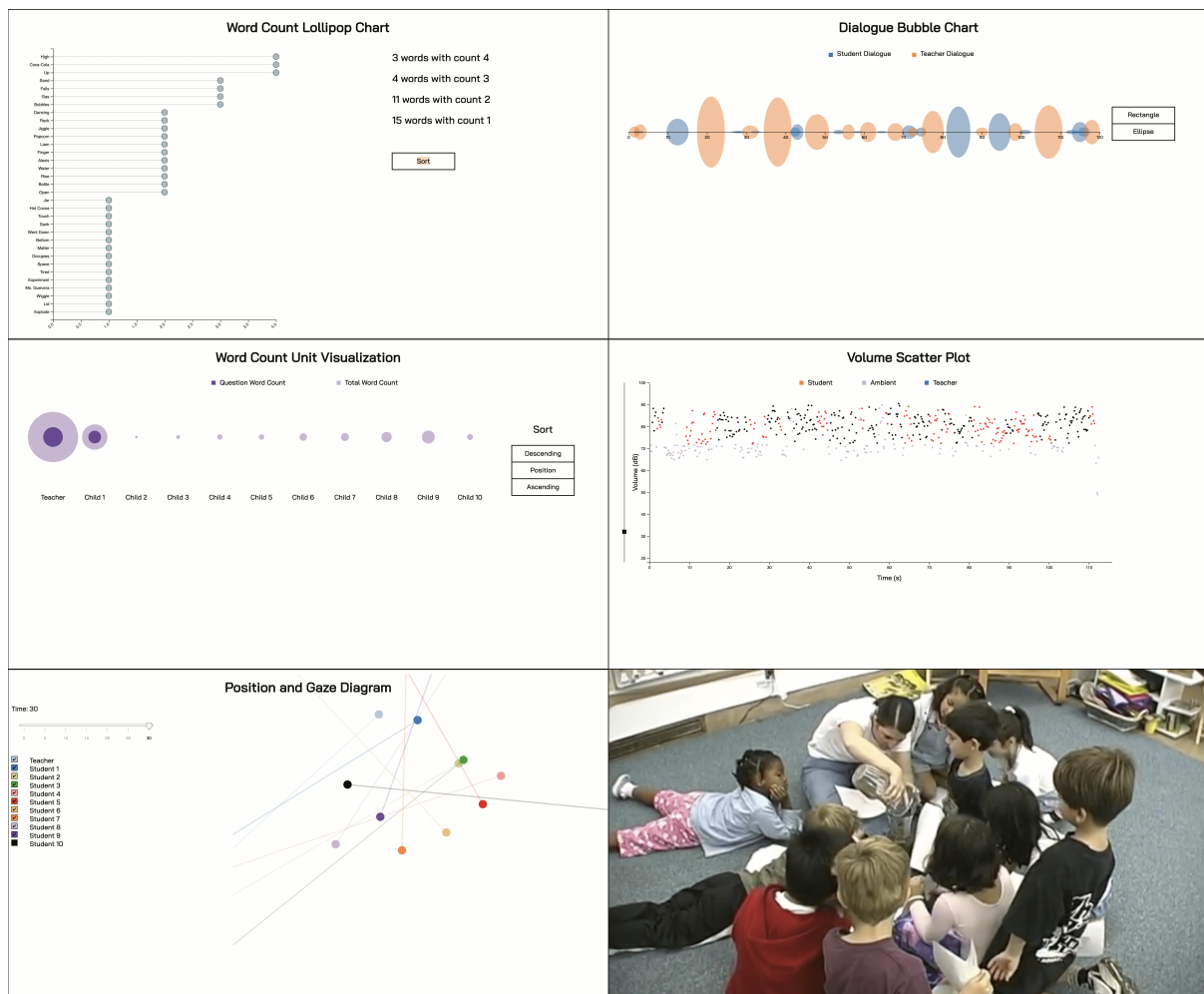


Figure 1. Screenshots from five different interactive visualizations of a two-minute video of classroom interaction. Interactive visualizations available at: <https://mrmathur.github.io/mos-visualizations/>

In the following we unpack each image and corresponding interactive visualization in this figure (from top left to bottom) by describing the a) specific representation and interaction techniques, b) encoding decisions and c) insights generated in each visualization. Our analysis aims to bridge language used by interaction analysts and visualization researchers in ways that help us discuss strengths and weaknesses of contemporary visualization techniques, including methodological commitments that are inherent to languages such as D3.js.

Visualization 1: Word count lollipop chart

Techniques

The first visualization is what is known as a lollipop chart, which is an extension of the more widely known bar chart. In this case, the length of each horizontal line across the X-axis encodes the number of times a word has been spoken during the 2-minute video of classroom interaction. Moreover, the chart supports standard forms of user interaction in two ways: Sorting and hovering (see Yi et al., 2007). Namely, the words can be sorted in ascending or descending order by using a button. Hovering over each circle also reveals the sentences in which the word was spoken and allows users to view and read these sentences.

Encoding Decisions

A database (i.e., a .csv file) was generated with each word, its frequency, and the sentences during which these words were spoken. Conversation spoken by teachers and students was occasionally in Spanish. The authors decided to only use the English translation of words in the video. Notably, articles and pronouns were also not included. With the database in place, a lollipop chart was made, by encoding the x position of the circle as the word length, and the y-axis as the rank (either ascending or descending, based on the user's selection). A lollipop

chart was used as opposed to a more standard bar chart because a lollipop chart affords more ways for users to interact with the data, in this case by reading sentences from which each word was derived.

Insights

Many basic insights are visible through this simple, standard representation. For example, while the central topic of this sequence of classroom interaction is the notion that “matter occupies space”, those particular words are rarely spoken by the teacher or students. In contrast, metaphors such as CocaCola, Sand, Bubbles, and Dancing are repeatedly uttered. A few student names are also recurrent, however not all student names are spoken. Furthermore, the possibilities to interact with this visualization allow users to consider the context in which each utterance is spoken at a sentence level offering very different ways to read turns of talk in comparison to traditional, non-interactive transcription methods. However, many insights are also lost through this type of representation in comparison to a more traditional transcript. For example, coherence of participants’ sense-making is difficult to recover even through interaction.

Visualization 2: Dialogue bubble chart

Techniques

The second visualization is a bubble chart, where each ellipse represents a conversation turn (i.e., in this case, uninterrupted speech that could span multiple sentences) spoken by either the teacher or a student. Ellipses are organized across a conventional timeline or time series display and the beginning and end (or left and right) of each ellipse marks the beginning and end of each conversation turn. Moreover, the visualization supports user interaction by allowing users to toggle between rectangles and ellipses to represent conversation turns, which allow users to explore subtly different aspects of conversation structure from this sequence of interaction. The users can also hover on a conversation turn (ellipse or rectangle), to display and read the dialogue spoken.

Encoding Decisions

A database was generated with each conversation turn, its content, and who spoke each conversation turn. Notably, each conversation turn was defined as a sequence of uninterrupted speech, which could span over multiple sentences. With the database in place, a bubble chart was made. The height of the ellipse indicates the number of words in each conversation turn. Thus, taller ellipses or rectangles (depending on the view selected by the user) indicate more words spoken during a conversation turn or a faster conversation turn. The left and right of each ellipse or rectangle indicate the beginning and end of each conversation turn. Thus, where ellipses or rectangles overlap indicates overlapping speech. The color of the bubbles represents who made each conversation turn. Hovering on a bubble reveals the content of the dialogue.

Insights

The bubble chart reveals several relevant insights. First, one can observe the general pacing of each conversation turn (i.e., length of conversation turns with respect to both the number of words and amount of time). This makes visible how the teacher speaks for much longer stretches of time and the parts of this interaction where students speak for long periods of time, often while asking a question. Likewise, the moments during this interaction when no one is speaking can be quickly identified. Moreover, overlapping ellipses (or rectangles depending on the view selected) are an interesting phenomenon. For example, these overlaps show that while students speak over one another they do not speak over or interrupt the teacher’s speech. Furthermore, the teacher utters many more words per conversation turn in comparison to students, who generally speak fewer words and for shorter periods of time. Finally, the ability to quickly hover over each ellipse or rectangle and read conversation provides a fundamentally different way to compare conversation turns in comparison to existing transcription methods.

Visualization 3: Word count unit visualization

Techniques

The third visualization is what is known as a unit visualization. It is named so because every individual from the video is represented by a spherical unit. Different attributes of this unit encode different characteristics. Here, the area covered by the outer and inner circles represent the number of total words and also questions uttered by each student and the teacher during this sequence of interaction.

Encoding Decisions

A database was generated with each individual, the word count for each individual, and the question word count for each individual. Notably, expressions and exclamations were not included in word counts for each individual.

A distinction between a statement and question was made by judging the intonation of the dialogue, with the intent being to explore the role and significance of questioning in the classroom. With the database in place, a unit visualization was created. The area of the lighter circle indicates the total word count for each individual whereas the area of each darker circle indicates the question word count for each individual (as represented by the legend). Importantly, area (as opposed to the use of radius) was selected to encode total and question word counts because the consensus in the visualization community is to use area, as it is a more intuitive indicator of quantity. The x position of each individual is determined by one of three modes or orders selected by the user.

Insights

The visualization supports comparative analysis across individual speakers with respect to the number of words uttered and the number of questions posed. For example, the teacher speaks many more words and also a far larger number of questions whereas students have much lower word counts and fewer questions. The visualization makes evident differences in contributions between students. For example, the visualization highlights child 1 as a significant speaker in the classroom; Notably, she also asks the teacher the largest number of questions. Altogether, the visualization is quite useful to analyze conversational parity or whether there are equitable opportunities to talk. However, the coherence and meaning of conversation are backgrounded.

Visualization 4: Volume scatter plot

Techniques

The chart is a scatter plot, where each dot represents a 0.2s instant in the video. The x position of the dot encodes the timestamp of the instant, the y position encodes the volume of the video at that instant, and the color represents the volume contributor, which is indicative of the source of the volume at that instant of the video. The user can interact with the visualization by rescaling the y-axis through a vertical slider, which allows them to zoom into relevant parts of the graph.

Encoding Decisions

Using a free, mobile application, a database was generated that encoded the volume organized by contributors from the sequence of interaction at time intervals of 0.2s. Volume contributors (i.e., Student, Teacher and Ambient Noise) at every time stamp were manually encoded by the authors. Key decisions were made about how to allocate volume to individuals. For example, at times multiple individuals spoke, and in this encoding scheme, the individual with the longest conversation turn was chosen. Moreover, ambient noise reflects a general category that groups other types of noises during this sequence of interaction not related to speakers. From this data, a scatterplot was generated which encoded time on the x-axis, volume on the y-axis, and the contributor as color.

Insights

The scatterplot makes particular phenomena visible that are quite different than other visualizations reviewed thus far. For instance, stretches of ambient sound (when no one is speaking) correlate to when the teacher is conducting the demonstration that grounds the sequence of interaction. Moreover, the variety of intonations of different speakers are visible in ways quite different from how intonation is typically represented by textual conventions of current transcription methods. Furthermore, average volumes can be viewed and compared, for example, to understand how loudness or strength of projection by a speaker influences classroom interaction that in turn encourages or dissuades others to speak.

Visualization 5: Position and gaze diagram

Techniques

The chart is a position and gaze diagram, where each dot is positioned according to a character's pixel values in the video, and the line represents the gaze of the character, at any instant of time. Users can use the provided time slider to observe the positions and gaze at specific intervals of time while filtering capabilities via checkboxes allow users to selectively view everyone's position and gaze, simplifying the visualization.

Encoding Decisions

To deal with the complexity and size of data, 5 second intervals were chosen. Moreover, pixel values from the video were used to indicate the position of the character, as opposed to a bird's eye view of the room. Likewise, the gaze in the video is in 3D space. However, the gaze was mapped in 2D space, because of the two-dimensional nature of a video. The gaze was defined as the line between every student (and teacher), and the point at which the field of view intersected with the screen's boundary. A database was generated with 5 second intervals, the

pixel values for each character's head position, and the pixel values for the point at which their gaze intersects with the boundary of the screen. Circles were plotted at the pixel locations of each student's and the teacher's head positions, and a line was generated from the head to the gaze point. Each circle was color coded to identify the corresponding person.

Insights

The visualization indicates aspects of how the teacher, individual students, and the class collectively focus and manage their attention or, in other words, how gaze is recruited and allocated. Notably, it highlights the ebbs and flows of how gaze is collected and released during this sequence of interaction in ways that are different than traditional representations and conceptions of how gaze is recruited and allocated. In this case, ebbs and flows refer to moments when participants focus on a particular object or person simultaneously for a period of time or look at many different objects simultaneously. For example, around the 5s mark, it becomes clear that all the students begin looking at the center of the classroom or experiment, as opposed to many different directions observed earlier. Most students look at the teacher, whereas the teacher's gaze fluctuates between students. Those sitting away from the teacher seem to focus their gaze on the teacher, whereas those sitting next to her seem to look at other students. These interesting aspects of spatial noticing also expand traditional conceptions of gaze: Namely, it is typically assumed that all participants have equal affordances in a shared space, but this representation allows one to see how certain participants may have more or less affordances depending on where they are positioned within a shared space. This pattern repeats across the two-minute sequence of interaction in response to how the teacher gathers and releases attention through her gesture and talk.

Discussion

We characterize the previous visualizations as interactive transcripts and focus our discussion on how these transcripts, on one hand, highlight particular techniques valuable for interaction analysis but, on the other hand, demonstrate the need to expand how people and context are represented by visualization mediums such as visualization grammars and programming languages like D3.js. We unpack these statements in order.

The preceding interactive transcripts make use of standard visualization techniques to encourage analysis of new phenomena and questions about this dataset and classroom interaction. For example, as we demonstrated, conversation turns can be compared in ways that are very different than traditional transcription techniques. Such comparisons support new ways to study the pace of conversation, turn-taking patterns, instances of overlapping talk, and volume of conversation in ways quite relevant to situative studies of classroom interaction that view such phenomena as central to people's opportunities to learn. Likewise, as we highlighted, techniques such as the interactive unit visualization are quite useful to analyze conversational parity or whether there are equitable opportunities to talk—something that is challenging to show and study with traditional transcription techniques. Still further, techniques demonstrated through the positioning and gaze diagram challenge typical assumptions about how all participants have equal affordances in a shared space, showing how certain participants may have more or less affordances depending on where they are positioned within a shared space.

While we suggest such interactive transcription techniques are valuable to interaction analysis beyond the example discussed in this paper, like all transcripts, these techniques are theory laden. Notably, in comparison to traditional transcripts, the transcripts in this paper embody theories and methodological commitments inherent to contemporary interactive visualization techniques. Particularly, they highlight how such techniques were not designed to represent people and notions of context important to traditions of interaction analysis as used in the learning sciences and CSCL communities (see Matuk, DesPortes, & Hoadley, 2021). Indeed, as described by Bostock et al. (2011), the goals of D3.js are to make it easy to implement popular and conventional visualizations (such as bar charts, line charts, scatter plots) as well as custom visualizations on the web. Like many existing visualization programming languages or libraries, D3.js embodies visualization grammars or formal models of describing visualizations including data, transformations, scales, and visual marks. Such grammars were designed for data that is already structured (e.g., as a CSV file), typically characterized as raw or objective, and not focused on depicting people's interaction or complex learning ecologies such as classrooms or the natural world.

Extending ideas reviewed at the beginning of this paper, we suggest there is a need and opportunity to expand the notion of a "visualization grammar" to more deeply consider how people and context are represented in ways that align more meaningfully with work in the learning sciences and CSCL communities, including recent efforts to expand the methodological commitments of interaction analysis (Krishnamoorthy et al., 2021; Marin et al., 2020; Silvis et al., 2022). For example, such work might develop interactive glyphs for interaction analysis specific to different settings, new types of interaction techniques to take on the perspective of participants as they engage in interaction, or extend sketching metaphors and commitments to equity and accessibility foregrounded

by programming languages such as p5.js that more meaningfully align with the iterative nature of qualitative traditions of interaction analysis (e.g., repeatedly watching video and iteratively developing transcripts).

Conclusion

We began this paper by reviewing how transcription is currently used in interaction analysis as well as our recent efforts to expand alternative visualization theories for qualitative research through integrative visualization. Subsequently, we illustrated and unpacked five different interactive transcripts that demonstrated visualization techniques to characterize types of classroom interaction in ways fundamentally different than traditional transcription approaches. We highlighted the value of such transcripts but also their weaknesses, emphasizing interactive transcripts provide another means to augment, not replace or automate, existing transcription practice for interaction analysis. Notably, we outlined the need and opportunity for researchers to explore how interactive transcription techniques can more deeply represent people and notions of context central to traditions of interaction analysis as used in the learning sciences and CSCL communities. Such work focuses on how visualization can expand qualitative traditions of interaction analysis in ways that are not focused solely on scaling research across contexts, but rather on studying the details of interaction within particular contexts from the perspective of everyday people, noting as others have that both lines of work can and should inform one another (Sherin, Kersting, & Berland, 2018; also see D'Angelo et al., 2020).

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