

Georgia State University

## ScholarWorks @ Georgia State University

---

Learning Sciences Faculty Publications

Department of Learning Sciences

---

2020

### Visualizing Qualitative Data: Creative Approaches for Analyzing and Demonstrating Lively Data from Diverse Learning Settings

Yong Ju Jung  
*Penn State*

Jaclyn Dudek  
*University of Alabama*

Shulong Yan  
*Penn State*

Marcela Borge  
*Penn State*

Soo Hyeon Kim  
*Indiana University-Purdue University Indianapolis (IUPUI)*

*See next page for additional authors*

Follow this and additional works at: [https://scholarworks.gsu.edu/ltd\\_facpub](https://scholarworks.gsu.edu/ltd_facpub)



Part of the [Instructional Media Design Commons](#)

---

#### Recommended Citation

Jung, Yong Ju; Dudek, Jaclyn; Yan, Shulong; Borge, Marcela; Kim, Soo Hyeon; Liao, Jian; Shapiro, Benjamin R.; and Zimmerman, Heather Toomey, "Visualizing Qualitative Data: Creative Approaches for Analyzing and Demonstrating Lively Data from Diverse Learning Settings" (2020). *Learning Sciences Faculty Publications*. 45.

[https://scholarworks.gsu.edu/ltd\\_facpub/45](https://scholarworks.gsu.edu/ltd_facpub/45)

This Conference Proceeding is brought to you for free and open access by the Department of Learning Sciences at ScholarWorks @ Georgia State University. It has been accepted for inclusion in Learning Sciences Faculty Publications by an authorized administrator of ScholarWorks @ Georgia State University. For more information, please contact [scholarworks@gsu.edu](mailto:scholarworks@gsu.edu).

---

**Authors**

Yong Ju Jung, Jaclyn Dudek, Shulong Yan, Marcela Borge, Soo Hyeon Kim, Jian Liao, Benjamin R. Shapiro, and Heather Toomey Zimmerman

# Visualizing Qualitative Data: Creative Approaches for Analyzing and Demonstrating Lively Data from Diverse Learning Settings

Yong Ju Jung (organizer), Penn State University, yyj5102@psu.edu  
Jaclyn Dudek (organizer), University of Alabama, dudekjac@gmail.com  
Shulong Yan, Penn State University, suy144@psu.edu  
Marcela Borge, Penn State University, mbs15@psu.edu  
Soo Hyeon Kim, Indiana University-Purdue University Indianapolis (IUPUI), skim541@iu.edu  
Jian Liao, Penn State University, jx11089@psu.edu  
Benjamin Rydal Shapiro, Georgia Institute of Technology, benjamin.shapiro@cc.gatech.edu  
Heather Toomey Zimmerman (discussant), Penn State University, heather@psu.edu

**Abstract:** This structured poster session aims to showcase novel approaches of qualitatively analyzing and communicating *lively data*—data that is complex, nuanced, multimodal, and multi-voiced. Such data is rich but also messy, often defying the traditional text-based forms of description and presentation. Therefore, the session pairs creative techniques and methods to analyze, triangulate, and/or visualize qualitative findings across multiple data sources (e.g., video, digital and physical spaces, participant artifacts, and patterns of movement) from diverse learning contexts (e.g., museums, libraries, outdoor spaces, and classrooms)—beyond showing transcriptions. The visual format of the session supports our goal of sharing and communicating rich data stories for further discussion with diverse audiences.

Life is messy, and learning is messy. Therefore, qualitative researchers within the practice-turn in the learning sciences investigate messy, boisterous, robust, and rich data. This structured poster session expands upon qualitative methodologies by exploring creative ways to analyze and visualize data holistically. Specifically, our session addresses the following objectives: (a) share creative methods to analyze and communicate with lively qualitative data, (b) discuss diverse methods to visualize qualitative data to better represent research questions, and (c) enact a studio approach that invites peer feedback and critiques about analysis, thereby adhering and deepening fidelity, validity, and trustworthiness of qualitative research in the learning sciences.

## Our rationales: Importance of creative ways to visualize our data

St. Pierre (1997) refers to “transgressive data,” or data that resists the primacy of textual/linguistic and linear forms. She argues that including such data can expand the scope of information and ways of knowing. Following this reasoning, our session explores the concept of *lively data*—data collected over various spatial-temporal instances, spanning digital and analogue spaces and mediums, and material artifacts. The session attempts to elucidate how we, as researchers and educators, attempt to wrestle data into a contrived academic form while being ethical to our participants and communicating with fidelity their experiences.

Drawing from previous works (Pink, 2008, 2013; St. Pierre, 1997; Sousanis, 2015; Thrift, 2008) to ground our approach, the session presents innovative and adaptive techniques—from six qualitative studies—to explore diverse types of qualitative data. Each poster shows emergent, playful, and unconventional techniques, as the session contributes to expanding academic discussion surrounding qualitative research by (a) responding to each research context, (b) demonstrating how visual and creative approaches provide multiple forms of analyses and perspectives, which may suggest new ways to show validity and trustworthiness, (c) providing a level of analytical and methodological rigor, and/or (d) offering a thorough and clear way to document and describe multiple layers of data so that it may be usable by other researchers (Gray & Malins, 2016). Accordingly, our session will contribute to rich discussion on how qualitative data can be creatively approached and rigorously analyzed by scholars in the learning sciences.

## Symposium structure

We propose this symposium as a structured poster session that includes dynamic presentations of data, and creatively visualized analysis, and active discussions with the session presenters, audience, and discussant. First, the organizers will introduce the goals and themes of the session. Each presenter will briefly introduce their posters, followed by time for the audience to explore and engage with presenters. Finally, our discussant, Dr. Heather Zimmerman, will initiate a whole-group discussion addressing how methods were adapted or created, and what other ways the field can build and improve a repertoire of visual approaches for future qualitative studies. Descriptions on each poster follow.

---

This is the author's manuscript of the article published in final edited form as:

Jung, Y. J., Dudek, J., Yan, S., Borge, M., Kim, S. H., Liao, J., Shapiro, B., & Zimmerman, H. T. (2020). Visualizing Qualitative Data: Creative Approaches for Analyzing and Demonstrating Lively Data from Diverse Learning Settings. *The Interdisciplinarity of the Learning Sciences*, 438–445. <https://repository.isls.org/handle/1/6670>

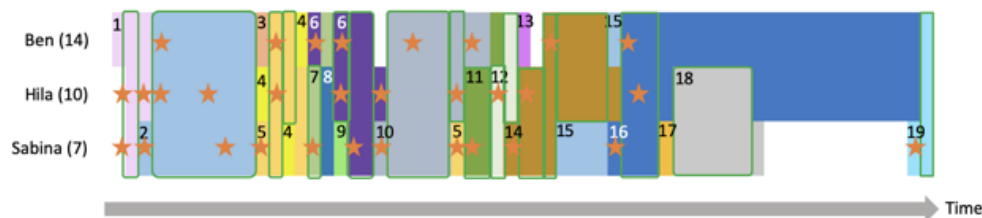
## Visualizing and understanding idiosyncratic situational interests during siblings' collective museum exploration

Yong Ju Jung, Penn State University

Children can develop varied interests although they were engaged in the same learning activities (Jung et al., 2019; Renninger & Hidi, 2016). In other words, even when a group of children (e.g., siblings, peers) performs learning activities together, each child can have idiosyncratic—sometimes conflicting—interests that may influence each other's learning and interest development. Yet, few studies have explored how multiple children collectively but differently develop their situational interests. Accordingly, this study presents a creative way, through visualizing such pathways, to understand how siblings were engaged in museum exhibits collectively as they developed idiosyncratic pathways of situational interest.

This study was conducted at a children's science museum located in the northeastern area of the USA. This study particularly focused on one family: Hailey (mother), Ben (boy, 14-year-old), Hila (girl, 10-year-old), and Sabina (7-year-old) (all pseudonyms). Multiple sources of data *in situ* were collected: pre-, on-site, and post-interviews (10 mins each), video recordings from stationary camcorders, and video recordings from head-mounted point-of-view cameras (i.e., GoPro™). Interaction analysis (Jordan & Henderson, 1995) was conducted with multi-modal analysis (Kress, 2011). The verbal transcriptions were merged with non-verbal notes, then the evidence of triggered situational interest (e.g., attention piqued, expression of excitement, surprise) was marked on the transcriptions using a spreadsheet. Then, the moments where their collective engagement happened were also marked. I repeatedly went back to these marked episodes and solicited what interactions emerge surrounding the episodes (e.g., what interactions helped their collective engagement).

Then, I created a map showing visualized pathways (Figure 1) that with which exhibits the siblings developed situational interest and they performed the collective engagement. The siblings' collective engagements were initiated, when one child's situational interest was sparked by an exhibit first, then, the child's expression of excitement drew the other children's attention (meaning, triggered situational interest). For example, Ben's situational interest in the exhibit #1 was triggered first, and then his siblings' attention followed, so that they were able to project collective engagement with the exhibit. Conversely, with the exhibit #16, Sabina's situational interest was triggered first, but Ben's situational interest maintained longer as he was deeply engaged while Sabina seemed to lose her interest (when they confronted a challenging problem). This visualization method helped for the understanding multiple learners' different pathways of moment-by-moment interest development by integrating information from multiple data sources. Further findings will be shared in the session.



**Figure 1.** The flow of Ben, Hila, and Sabina's exhibit exploration as time (horizontally) went by. Numbers indicate different exhibits. Orange stars indicate the moments when they expressed their triggered situational interests. Green lines indicate when their collective engagements occurred. For example, the light pink part on the very left shows that Ben initiated his engagement with the exhibit #1 and then Hila and Sabina followed; Sabina left earlier and moved to the next exhibit while Ben and Hila stayed with the first one longer.

## Placemaking as meshworking: using creative cartographies to inform emplaced ethnography

Jaclyn Dudek, University of Alabama

This study explores creative ways of mapping informed by the theories of Deleuze and Guattari (1987) and Ingold's concept of meshwork (2011). *Meshwork* is Ingold's term to describe the fluid interconnection between organisms' activity with their environment, which become entangled with one another. Meshworking, therefore, has implications for understanding emplacement and embodiment within ethnographic methods. Using a technique described as *meshwork mapping*, various "lines" or modes of movement and activity are charted to show how a community inscribes the space through learners' performances and enactment of place. The maps inform the multimodal ways people make place.

The participants were community of performers collectively called Shakespeare in the Arb (SITA) and are made up of amateur performers who stage a Shakespeare play in a university arboretum. The unique experience of SITA comes from the environmental staging of the plays. There is no fixed stage; instead, the audience follows the action through different locations in the Arboretum. The staging takes advantage of the natural settings.

The analysis used a *placemaking as meshworking* approach to understand how the SITA community inscribes and aligns their placemaking practices with the Arboretum. Meshworking was operationalized as an analytical tool to examine how the community inscribed and edited the space of the Arboretum over time. The community’s activities were categorized and mapped to visualize how the community “made lines” of different kinds of movement, meaning, and relationships with the arboretum (both explicit and implicit). Thus, various kinds of data were mapped and then layered to visualize the entangled connections that made up the community’s praxis (Table 1 and Figure 2).

Before this work, a lack of empirical examples and overly dense theoretical framing has kept meshworking outside the purview of designers, educators, and practitioners. Meshworking as an analytical tool attends to multiple actions, data sources, and movements (of both human and more-than-human bodies/materials) at the same time. Visually mapping sensory, embodied data helps elucidate the lived and lively-imagined experiences of people as they learn, work, and play together.

Table 1: Excerpt of meta-performance lines of The Tempest performance in SITA (2017)

Storyline	Arboretum Feature in Wanderline	Map ID Key	Cue Line
Shipwreck Prologue	Heathdale	1	Put the wild waters in this roar, ally them.
Prospero’s sleeping charm and Ariel’s last charge	In front of Oberon tree, near boardwalk on the edge of the Main Valley	2	To thy strong bidding task, Ariel and all his quality.
Caliban’s home	Split tree	3	I must eat my dinner.
Lovers meet	Split tree east	4	Heavens, my language!
Shipwrecked sailors	East Valley south hill	5	Though this island seems desert.

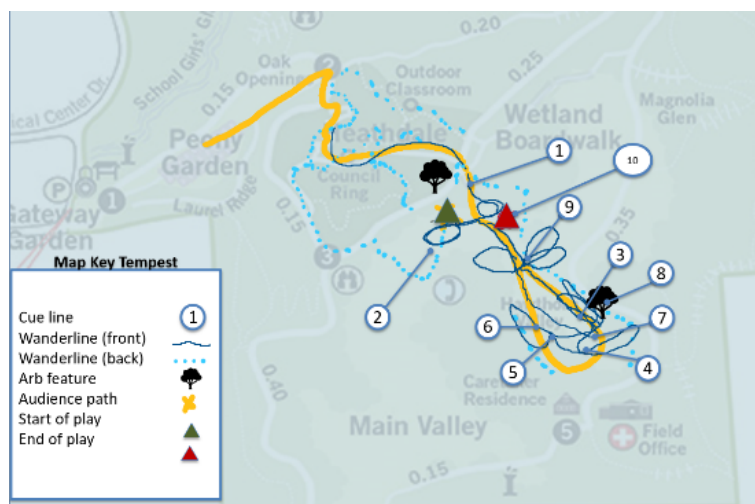


Figure 2: Meta-performance lines of The Tempest performance in SITA. The map corresponds to Table 1.

## An integration approach to understand collaborative learning from design failure activity

Shulong Yan & Marcela Borge, Penn State University

When discussed learning from failure, scholars often examined either the learning products or process (Deliema, 2017; Kapur, 2008). However, failure is both a product of past actions and an ongoing learning process (Litts & Ramirez, 2014). This study visualized the development of product and dialogue process from one group’s different design phases - from gathering information to create sketch to actualizing the plan with LEGO.

The data was selected from one design group's three learning from design failure events occurred in an afterschool design club. The group first gathered information about the client to generate design prototype, then went through two rounds of design evaluation with a checklist including clients' information followed design iteration. Transcript was used along with Social Network Analysis (SNA) method to visualize temporal change (Figure 3, left). Instead of traditional way of defining the node as speaker, each node in this method was either an item in the checklist, an evaluation outcome, or a design decision. Edges were defined as turns within the conversation between the onset and offset of a topic being discussed. We then linked the transcript and the artifact iteratively to create labels for design artifact produced in design prototype and iteration phase (Figure 3, right).

We found that product or process only represented partial change occurred in group collaboration. The change of design functions, design positions, and complex connections between client's needs and the design can only be understood through iterative and integrated examining between artifact and dialogues. For example, from Phase I to Phase III, the group added a play area on the up-left corner (blue top with red and white body). This change was discussed in their dialogue. However, only when linking the dialogue to the artifact, we can visualize the position of this newly added design. Adopting the concept of nodes and edges and temporal analysis from SNA into qualitative research, we were able to visualize how group's dialogue around their design in learning from design failure events changed over time. Artifact is both an object of thought and also thought in action which actualized the ideal form of thought (Cole, 1988). In return, the creation of the artifact served as an object to think with which mediated the increasing conversation complexity (Ackermann, 2001).

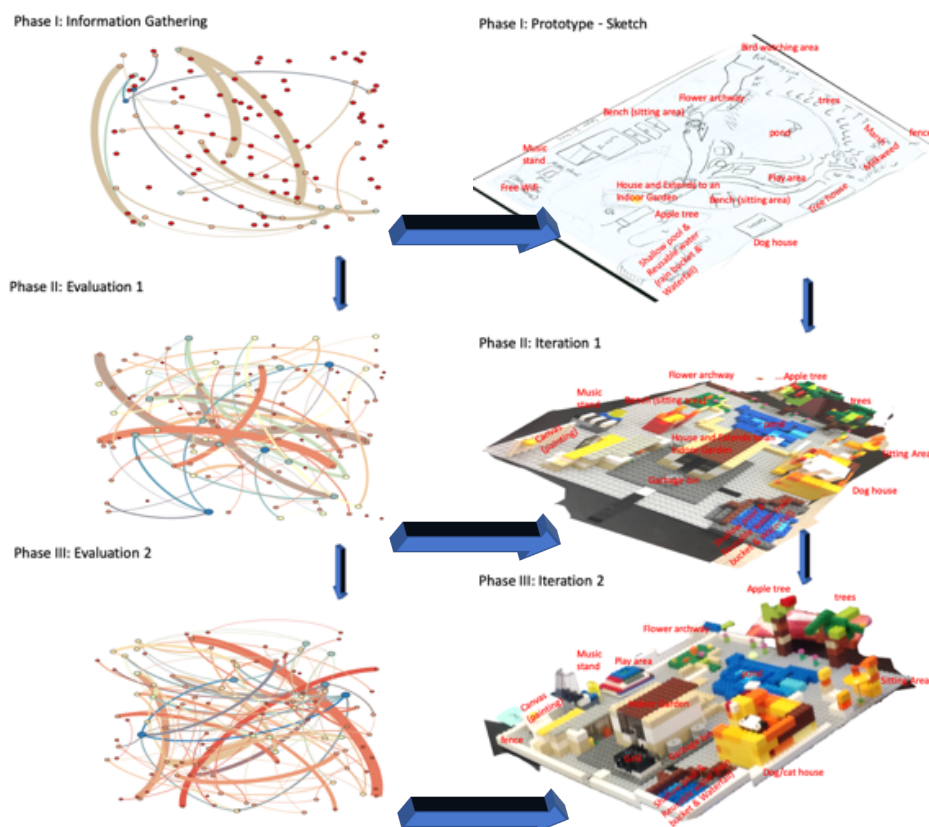


Figure 3. Development of design ideas

## Design timelines to understand families' creative engineering practices at engineering workshops in libraries

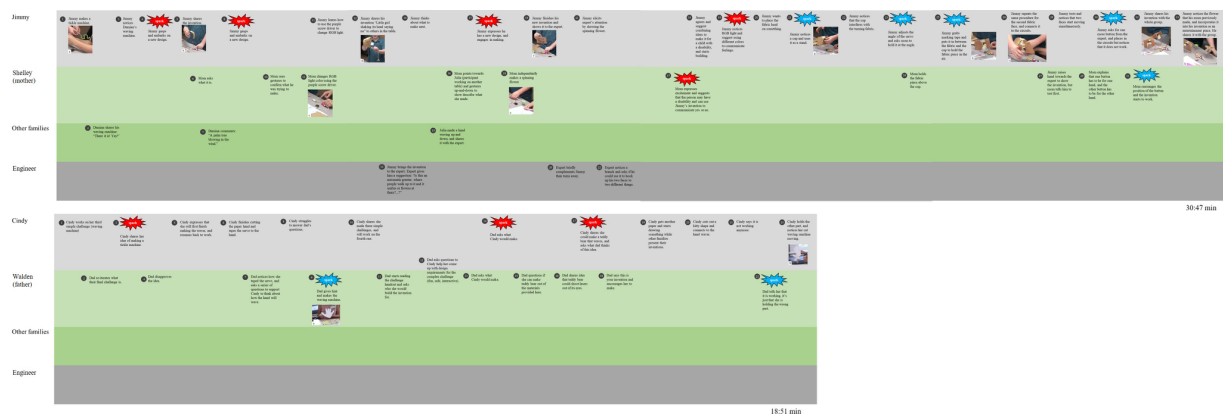
Soo Hyeon Kim, Indiana University-Purdue University Indianapolis (IUPUI)

This study reports on the use of design timelines from a qualitative case study of two families' creative engineering practices at an engineering workshop from two rural libraries. The goal is to elucidate how families' creative engineering practices accumulate and shape their final products, and to develop methodological tools to advance studies of making and engineering in informal settings. In this study, creative engineering practice is operationalized as an activity that gives rise to externalized forms of novel and feasible ideas or solutions when

families address a design problem. I developed *Distributed Creativity across Everyday Expertise Framework* by bringing together distributed views of creativity (Sawyer & DeZutter, 2009) and everyday expertise framework (Bell et al., 2006) to explore how families' sociomaterial experiences influenced families' creative engineering practices and products.

This study focused on the second iteration of an hour-long engineering workshops in 2017 from a larger design-based research. 75 participants consented (42 children, 33 adults). Two engineers led the workshops that utilized *littleBits* for families to build inventions that addressed a design challenge. Participants' interaction was video-recorded (~32 hours). The unit of analysis was parent-child pair. Two parent-child pairs were qualitatively analyzed using interaction analysis (Jordan & Henderson, 1995). Based on content logs, invention logs, and transcriptions, two parent-child pairs' episodes around novel idea generation and feasible solution generation during design challenge were represented through the visual timelines with an analytical framework.

Findings from the design timelines illustrated two different ways in which families' sociomaterial experiences influenced their creative engineering practices and the products (Figure 4). Jimmy's family experienced frequent sociomaterial interaction within and outside the family that supported them to discover new inspiration. As such, ideas continued to accumulate, evolve, and expand. Cindy's family engaged in short-duration of sociomaterial interaction and engaged in a straight-forward design process with more clear design goal. My findings demonstrate how design timelines acted as methodological tools to illuminate the moment-to-moment lived data of families' creative engineering practices and expand understanding of when, how, and from whom the idea and solution sparks were elicited to shape the families' creative engineering practices and the products.



**Figure 4.** Design timelines of Jimmy's family (top) and Cindy's family (bottom). Discourse and gestures from the child and social others (parent, other family members, expert) that influenced the emergence of idea sparks (red) and solution sparks (blue) are included.

## Place-based concept map: a new approach to understand sensemaking in foreign language learning outside classrooms

Jian Liao, Penn State University

Sensemaking plays an important role when foreign language learners acquire a language in daily lives since the meaning of the language is shaped by the context and many concepts cannot be translated into the first language precisely. However, existing studies have not provided an effective way to analyze how learners make sense of concepts from the lively data. This study proposes an approach to visualize the content and process of sensemaking in foreign language learning activities outside classrooms.

Place-based foreign language learning uses places and the geophysical, cultural and historic resources of the places as a foundation to improve not only linguistic knowledge, but also other types of knowledges relevant to communicative competences in real conversational situations (Holden & Sykey, 2011; Liao & Lu, 2018). Concept map is a diagram to depict the concepts and relations among concept. Concept map has been used in education as a learning and evaluation tool for many years (e.g., Cañas et al., 2015). However, few studies have explored how concept map could be applied in place-based learning as a data analysis tool.

In a case of place-base foreign language learning, eleven English-as-Foreign-Language (EFL) learners in China were chosen to learn English relevant to an arboretum in America via Keebot, a telepresence robot that can be controlled remotely by the learners to move around at the garden of the arboretum (Figure 5). Also, the camera and the screen on the robot supported learners to communicate with the local English instructors. Based

on learner-instructor conversation about an *Oak Tree*, a place-based concept map has been drawn with different node shapes and colors to show to what degree the conversation topics had been expanded and to what degree the learner had her/his agency to initiate topics (Figure 6).

This place-based concept map provides a diverse and reliable way to visualize the content and the process of sensemaking in foreign language learning outside classrooms. The shapes and the colors of the nodes in the map can be defined variously based on the research goal of the study. The concept maps generated from different learners/instructors/locations/activity designs are comparable for further analysis. Additionally, it is possible to extend the application to other fields of place-based education, such as geography, biology, and history.



Figure 5. Foreign language learning via a telepresence robot from the researcher and student views

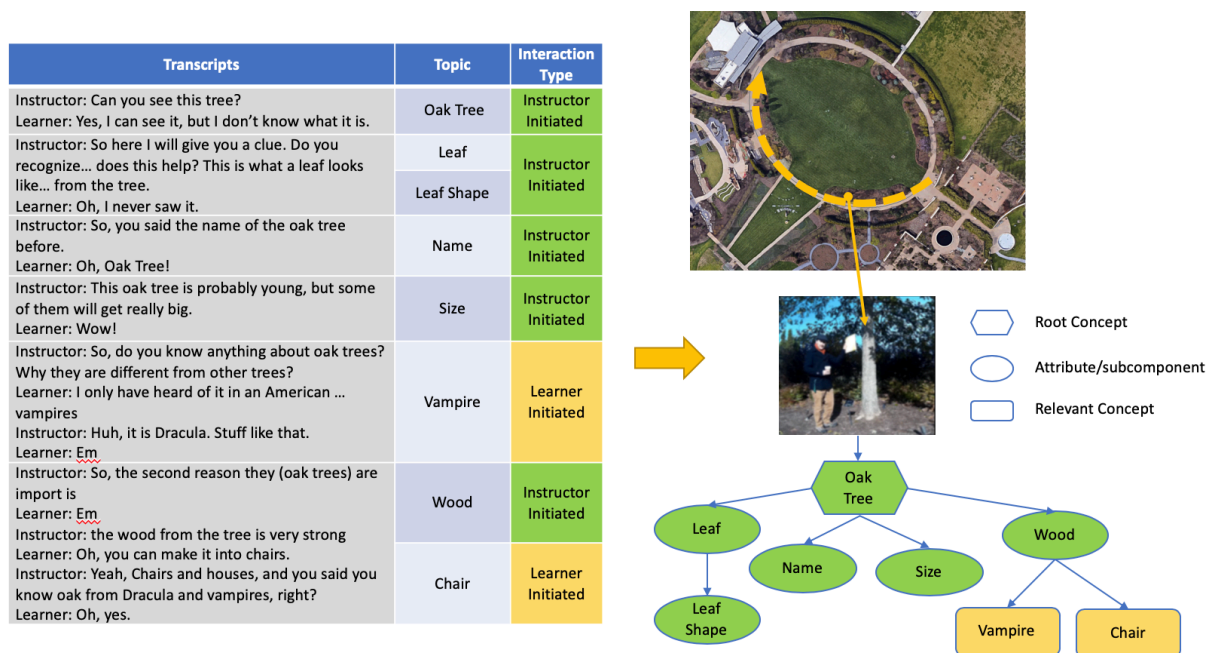


Figure 6. Place-based concept map

## Extending qualitative research through integrative visualization

Benjamin Rydal Shapiro, Georgia Institute of Technology

The development and use of computational approaches to make sense of data collected in collaborative learning contexts is expanding rapidly in educational research. However, developing and using these approaches in ways that maintain a commitment to theory and situational context is a significant challenge (Wise & Schwarz, 2017). This paper contributes to this symposium by reviewing previously published work outlining integrative visualization, a human-centered process that leverages information visualization to extend qualitative research methods (Shapiro, 2019). As described in this work, “integrative visualization extends visual methods of exploratory data analysis (Tukey, 1977) to iteratively transcribe data collected in context in order to organize data and develop codes, categories, units of analysis, and questions that support the development of grounded theory (Glaser & Strauss, 1967) and new computational tools.” In particular, integrative visualization extends the practice of “integrative diagramming” (Strauss, 1987) through techniques of exploratory data analysis and is summarized as follows:





Figure 8. Integrative visualization process

This paper shares how integrative visualization supported the development and use of interaction geography, an approach to describing, representing, and interpreting collaborative interaction across the physical environment (Shapiro et al., 2017). Figure 9 illustrates outcomes of this approach as used to explore data about visitor activity in a museum context (Left) and pre-service social studies teachers making and following historical walking tours (Right). Both these projects draw from work in this symposium including a growing body of research that views walking as a form of public discourse (see Marin, 2013; Zimmerman et al., 2016; Hall et al., forthcoming) where learning often arises either from moments where people “make places” to engage with entities or phenomena of interest (Lave et al., 1984; Ma & Munter, 2014; Christidou, 2018; Steier, 2014) or alternatively, designed pedagogical sequences where people move through built and natural environments to learn (Taylor & Hall, 2013).

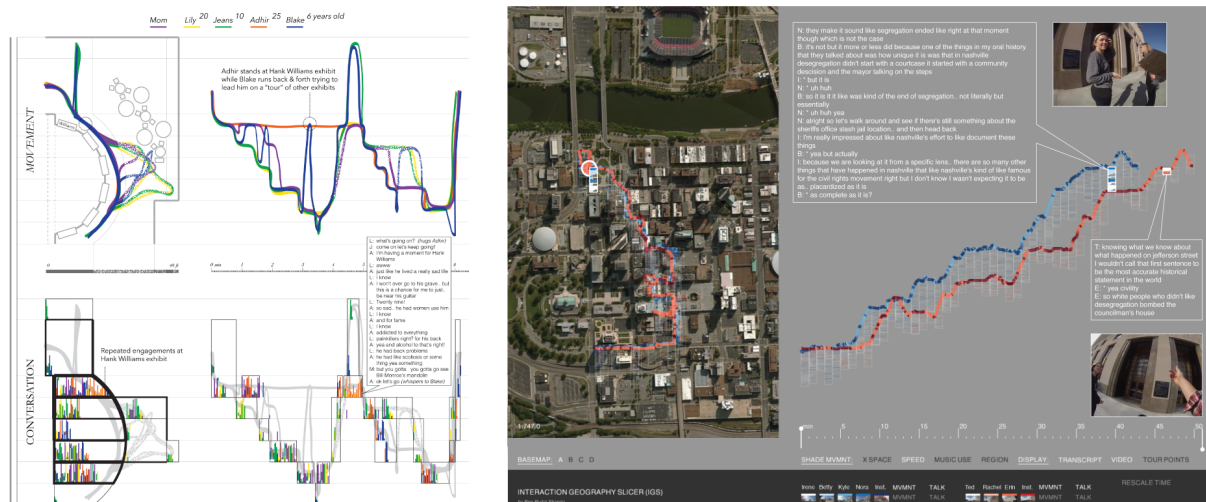


Figure 9. Screenshots from dynamic visualization tool called the interaction geography slicer (IGS) that show: (Left) a family of five’s movement and conversation in a museum gallery space over space and space-time, (Right) the movement and conversation of two groups of pre-service social studies teachers making (blue path) and following (red path) historical walking tours over space and space-time in Nashville, TN.

## References

- Ackermann, E. (2001). Piaget’s constructivism, Papert’s constructionism: What’s the difference. *Future of learning group publication*, 5(3), 438.
- Bell, P., Bricker, L. A., Lee, T. R., Reeve, S., & Zimmerman, H. T. (2006). Understanding the cultural foundations of children’s biological knowledge: Insights from everyday cognition research. In *Proceedings of the 7th international conference on Learning sciences* (Vol. 2, pp. 1029–1035).
- Cañas, A. J., Novak, J. D., & Reiska, P. (2015). How good is my concept map? Am I a good Cmapper? *Knowledge Management & E-Learning: An International Journal*, 7(1), 6-19.
- Christidou, D. (2018). Art on the move: The role of joint attention in visitors’ encounters with artworks. *Journal of Learning, Culture and Social Interaction*, 19, 1-10.
- Cole, M. (1988). Putting culture in the middle. *Cultural psychology: A once and future discipline* (pp.116-145). Cambridge, MA: Harvard University Press.
- Corner, J. (1999). The agency of mapping: Speculation, critique and invention. In D. Cosgrove (Ed.), *Mappings* (pp. 213-252). London, UK: Reaktion Books.
- Deleuze, G., & Guattari, F. (1987). *A thousand plateaus*, (B. Massumi Trans.). Minneapolis: University of Minnesota Press.
- DeLiema, D. (2017). Co-constructed failure narratives in mathematics tutoring. *Instructional Science*, 45(6), 709-735.
- Eisner, E. W. (2002). *The arts and the creation of mind*. New Haven, CT: Yale University Press.

- Glaser, B., & Strauss, A. (1967). Grounded theory: The discovery of grounded theory. *Sociology the Journal of the British Sociological Association*, 12(1), 27-49.
- Gray, C., & Malins, J. (2016). *Visualizing research: A guide to the research process in art and design*. London, UK: Routledge.
- Hall, R., Shapiro, B.R., Hostetler, A., Collins, H., Owens, D., Daw, C., Fisher., and the Space, Learning & Mobility Lab. (accepted with revisions). Here-and-then: Learning by making places with digital spatial story lines. To appear in a special issue of *Cognition & Instruction* on “New Genre of Learning on the Move”.
- Holden, C. L., & Sykes, J. M. (2012). Leveraging mobile games for place-based language learning. *Developments in Current Game-Based Learning Design and Deployment*, 1(2), 1-18.
- Ingold, T. (2007). *The life of lines*. Abington: Routledge.
- Jordan, B., & Henderson, A. (1995). Interaction analysis: foundations and practice. *Journal of the Learning Sciences*, 4(1), 39–103.
- Jung, Y. J., Zimmerman, H. T., & Land, S. M. (2019). Emerging and developing children’s situational interests during tablet-mediated biology education activities at a nature center. *Science Education*, 103, 900-922.
- Kapur, M. (2008). Productive failure. *Cognition and Instruction*, 26(3), 379-424.
- Kress, G. (2011). Discourse analysis and education: a multimodal social semiotic approach. In R. Rogers (Ed.), *an introduction to critical discourse analysis in education* (pp.205-226). New York, NY: Routledge.
- Lave, J., Murtaugh, M., & de la Rocha, O. (1984). The dialectics of arithmetic in grocery shopping. In B. Rogoff and J. Lave (Eds.), *Everyday cognition: Its development in social context* (pp. 67–94). Cambridge, UK: Cambridge University Press.
- Liao, J., & Lu, X. (2018). Exploring the affordances of telepresence robots in foreign language learning. *Language Learning and Technology*, 22(3), 20-32.
- Litts, B., & Ramirez, D. (2014). Making people fail: Failing to learn through games and making. *Proceedings GLS*, 10, 160-166.
- Ma, J. Y., & Munter, C. (2014). The spatial production of learning opportunities in skateboard parks. *Mind, Culture, and Activity*, 21(3), 238-258.
- Marin, A. M. (2013) *Learning to attend and observe: parent-child meaning making in the natural world*. Ph.D. Dissertation. Northwestern University.
- Pink, S. (2013). *Doing visual ethnography*. London, UK: Sage.
- Pink, S. (2008, September). Mobilising visual ethnography: Making routes, making place and making images. In *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research* (Vol. 9, No. 3).
- Renninger, K. A., & Hidi, S. E. (2016). *The power of interest for motivation and engagement*. New York, NY: Routledge.
- Sawyer, K., & DeZutter, S. (2009). Distributed creativity: How collective creations emerge from collaboration. *Psychology of Aesthetics, Creativity, and the Arts*, 3(2), 81–92
- Sousanis, N. (2015). *Unflattening*. Cambridge, MA: Harvard University Press.
- Shapiro, B.R. (2019). Integrative visualization: exploring data collected in collaborative learning contexts. In *Proceedings of the 13th International Conference on Computer Supported Collaborative Learning (CSCL) 2019, Volume 1* (pp. 184-191). Lyon, France: International Society of the Learning Sciences.
- Shapiro, B.R., Hall, R. & Owens, D. (2017). Developing & using interaction geography in a museum. *International Journal of Computer-Supported Collaborative Learning*, 12(4), 377-399.
- Steier, R. (2014). Posing the question: Visitor posing as embodied interpretation in an art museum. *Mind, Culture, and Activity*, 21(2), 148-170.
- St. Pierre, E. A. (1997). Methodology in the fold and the irruption of transgressive data. *International Journal of Qualitative Studies in Education*, 10(2), 175-189.
- Straus, A.L. (1987). Integrative diagrams and integrative sessions. In A.L. Strauss, (Ed.), *Qualitative analysis for social scientists* (pp. 170–182). Cambridge University Press.
- Taylor, K. H., & Hall, R. (2013). Counter-mapping the neighborhood on bicycles: Mobilizing youth to reimagine the city. *Technology, Knowledge and Learning*, 18, 1-2: 65-93.
- Thrift, N. (2008). *Non-representational theory: Space, politics, affect*. Abingdon: Routledge.
- Tukey, J. W. (1977). *Exploratory Data Analysis*. Addison-Wesley.
- Wise, A., & Schwarz, B. (2017). Visions of CSCL: Eight provocations for the future of the field. *International Journal of Computer-Supported Collaborative Learning*, 12, 423–467.
- Zimmerman, H. T., Land, S. M., Maggiore, C., Ashely, R. W. & Millet, C. (2016). Designing outdoor learning spaces with iBeacons: Combining place-based learning with the Internet of Learning Things. *Proceedings of the 12th International Conference for the Learning Sciences. Vol.2*, 942-945.