Feel the story in your hands: Tangibles for exploring collaborative scientific storytelling

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Abstract

In this position paper, we propose that tangible objects, passive or active, can be used for scientific data storytelling. Tangible devices can convey data to users in a more collaborative manner, helping users feel connected to the task. This can foster knowledge transfer and collaborative sensemaking and connect the user at an emotional level for data comprehension.

Keywords

Scientific Data Storytelling, Tangibles, Emotions, Collaboration

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1 Introduction and Motivation

Tangible User Interfaces (TUIs) have long shown how physical artifacts can support intuitive, collaborative interaction with information [7]. They have been used to physically represent digital data for the past few decades and are increasingly being integrated into various domains and applications. Controlling how data can be represented is the greatest tangible freedom, and it is being applied in fields like psychology, education, gaming, programming, and visualization. Meanwhile, information visualization transforms complex datasets into perceivable patterns and relationships, creating the raw material for interpretation. As this interpretation can be challenging, storytelling offers a way to convey data more effectively and expressively with visual narratives [11].

In this position paper, we argue that tangible user interfaces, when used for collaborative scientific data storytelling, can enhance the affection, cognition, and engagement among users. Tangibles can make data stories physically graspable, turning abstract information into objects people can manipulate together. This co-located, hands-on interaction naturally supports collaboration as users point, move, compare, and negotiate meaning. Tangible storytelling can heighten emotional engagement by making the story feel personal, shared, and embodied rather than distant and purely visual [7]. Tangible objects can serve as a means of control, providing the user with agency over the flow of the story. Tangibles are also known for enhancing emotions, which, in turn, may enhance comprehension. We further argue that tangible devices can be classified as active or passive and that both can serve as a coordinator for the collaboration among users. An investigation into how a passive and active tangible device can further provide insights into how users respond in a co-located space. Furthermore, we question how tangibles could change the way we speak about data and how different tangible shapes might impact storytelling performance.

2 Collaborative Storytelling with Tangibles

Tangibles are known to enhance teamwork participation; hence, they provide better collaboration [21]. Studies have been carried out in many fields relating to tangibles and their ability to enhance understanding and build relationships around complex data structures and strenuous tasks in a collaborative way. Tasks like data visualization and information interpretation from extensive datasets interactively can be carried out with the help of tangible devices [10, 17]. The role tangibles can play in shifting the screen-based comprehensive scientific data analytics to co-located embodied data sensemaking is an interesting approach that can enhance collaboration dynamics and the emotional engagement between the users.

The culture of storytelling goes way back to ancient times, when storytelling was a way of not only connecting people in the community but also imparting knowledge; hence, it is referred to as the "second-oldest profession" in the world [3, 11]. In the emerging world where data is referred to as the new fuel, especially complex scientific data, it is essential that there are new mediums of understanding this data for everyone. Scientific data storytelling is the communication of complex data visually with narratives, yet it has been mainly interface-based. There have been efforts to represent scientific data stories with indifferent forms, such as embodied interactions, gesture-based interaction, gaze-based interaction, augmented and virtual reality-based interaction, tangibles, etc., [1, 18, 20]. Among all these, tangibles are an interesting choice for representing data-driven scientific storytelling, as the user can engage and control actual data through a tangible object.

Physical interfaces have been used for a long time for collaborative learning and education; one of the well-known examples is the abacus for the foundational learning of math [9]. This process of learning scientific data via tangibles in the form of storytelling can be applied to modern-day tangible user interfaces and tangible objects. The first attempts of tangible storytelling were put together by the MIT Media Lab Tangible Media Group with their project Triangles and Narratives [4]. Authors Harley et al. [5] in their work

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emphasized the term "tangible narratives," where an object can represent a metaphor for a story segment or contribute to the narrative of the story itself. Scientific data stories are created with narrative and the scientific visualization of data, which can be volumetric, multivariate, multidimensional, etc., in nature. Tangibles are highly valued artifacts because of their ability to convey more than just one dimension of the data to the user. Tangibles are also a way to transfer knowledge, communicate feelings, foster bonding, collaborate, and exchange opinions between users and the data [6, 7, 12].

One way to motivate tangibles in collaborative data storytelling is to connect them to established storytelling functions such as communicating a narrative and explaining data, linking separated story elements, enhancing structure and navigation, and enabling controlled exploration [13]. Tangible interfaces can materialize these functions as shared "story artifacts" that participants can point to, pass around, arrange, and manipulate—making narrative cues and data states visible and discussable in the group. Collaborative data storytelling becomes a relational activity when tangibles mediate the evolving dynamic between storyteller (e.g., scientist, educator, communicator) and audience by supporting turn-taking, joint attention, and negotiated interpretation while still allowing guided exploration within boundaries set by the storyteller.

3 Active and Passive Tangible devices for Collaborative Storytelling

For storytelling, tangibles can be classified into two main types: active and passive (see Figure 1). Passive tangibles can support collaborative storytelling by acting as shared, graspable story artifacts that make roles, values, and interpretations discussable in the group [2, 14]. For example, in a climate-data setting, participants place tokens representing stakeholders (e.g., community, infrastructure, ecosystems, future generations) on a map or timeline as they interpret flood risk, heatwaves, and other environmental factors. Because tokens are movable and easy to hand over, they scaffold turn-taking, pointing, and negotiated meaning. Participants literally "move" a narrative forward by rearranging who is affected, where impacts concentrate, or which trade-offs matter most. Emotionally, passive tokens may work well as empathy anchors, for example, memorial tokens for recollection or local craft pieces that hold cultural values, and many more. Participants can attach feelings and responsibility to concrete symbols better than to abstract charts, which can make the story feel more personal and shared.

Active tangibles add another layer by providing feedback that can orchestrate the group's attention and pace the narrative [16, 19]. For example, an LED/haptic-based "narrative beacon" can mark story intervals through changes in glow or vibration as the group explores climate timelines. This kind of active cue supports collaboration by synchronizing when the group pauses, reflects, or transitions, and it can help a storyteller gently explore (for example, "hold here, notice this shift," then "continue to the next chapter"). Emotionally, active feedback can amplify key moments; e.g., a stronger haptic pulse near critical thresholds can evoke urgency and make collective moments of discovery or insights more assertive, while still keeping the interaction lightweight and shared, especially when everyone can see or feel the cue at the same time.

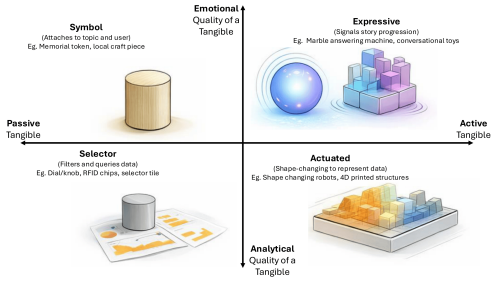

Figure 1: Passive and active tangibles and the relation between the emotional and analytical scales.

As seen in Figure 1 the active nature of the tangible promotes more emotional and expressive triggers for the user, and a passive tangible can be used for encoding data.

4 Examples of Tangibles for Collaborative Storytelling

Applications of tangibles in the field of data storytelling are immense, because an artifact can be used for denoting the data, and it is easier to manipulate the data because the agency of control is in the hands of the user. But with the introduction of large language models (LLMs), these roles are changing; artificial intelligence (AI) is emerging as a storyteller itself [8]. With these changing roles, it is possible to make the tangibles a storyteller, which can change facades and transform in real time to adjust to the changing pace and style of the story.

Many applications of tangibles are used in scientific data storytelling, like TangibleNet, which is a projector-based AR system for live and synchronous data storytelling for network visualizations. Here a presenter manipulates a node-link diagram using physical, double-sided magnetic pieces to perform interactions during a presentation. It was built to make real-time network storytelling easier and autonomous, with intuitive interactions in live storytelling contexts for presenters [15].

Another example can be that a spherical object as shown in Figure 2 can be used for performing co-located collaborative storytelling, which can enhance the feeling of empathy among the users. When we talk about data that visualizes climate change and its impact on the environment, we have to consider the statistics for factual evidence. But sometimes users are not able to connect as deeply to statistical numbers, and hence the feeling of awareness, which should arise between the users to acknowledge climate change and its impacts, does not arise. The users do turn-taking with the sphere in hand and listen to each other and try to understand other's perspective on the data visualization and the narrative presented.

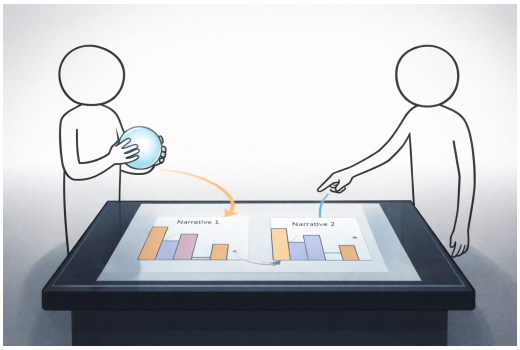

Figure 2: Collaborative storytelling session where the users co-occupy, acknowledge, and discuss the impacts of global warming by turn-taking with the tangible.

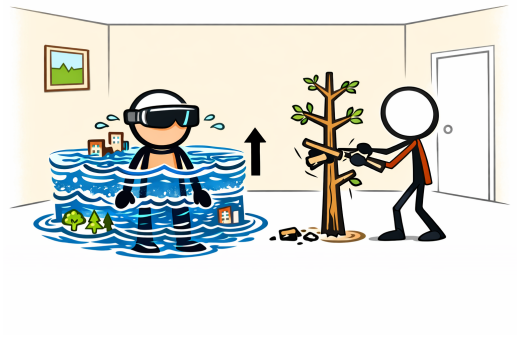

Figure 3: Collaborative scientific data storytelling in AR where the users can feel the immersion yet stay in the reality of holding the tangibles.

Another example can be in a co-located setup: two users collaboratively tell a climate data story; one wears AR glasses and experiences sea-level rise around their body. Refer to Figure 3. One user is in charge of a tangible tree stick, where snapping a branch represents forest loss, immediately causing the water around the other user to rise in AR. This shared physical action and embodied AR consequence creates an emotional "cause-and-impact" moment, which can trigger numerous emotions like guilt, urgency, empathy, and kindness. Together they discuss the scientific data links between deforestation, temperature increase, and sea-level rise as a lived, interactive narrative. Immersive interactive examples like these can be used to foster knowledge transfer while maintaining scientific attitude in children to raise awareness for our actions and climate change. Augmented reality is a perfect mix between giving the users a feel of co-located collaboration while being in co-location as well as giving them the feel of holding the tangibles and seeing them[15].

5 Discussion and Conclusion

Tangibles can shift scientific data storytelling from a mainly interface-based activity to a co-located, relational form of sensemaking. The passive and active spectrum of tangibles becomes a key design aspect where passive tangibles (e.g., tokens, artifacts, disks, etc.) can encode data or represent stakeholders to anchor discussion and empathy, while active tangibles (e.g., LED/haptic cues) can pace narrative intervals, synchronize story transitions, and amplify critical moments such as thresholds. Despite this, the tangible devices must be calibrated to avoid false indications or biased interpretation in scientific contexts. Overall, we argue that studying how different tangibles and levels of actuation can influence collaboration dynamics, emotional engagement, and comprehension is a promising direction for embodied systems that remain scientifically responsible.

About the Authors

Susmita Khadse. I am an HCI researcher and PhD candidate at the Interactive Media Lab Dresden, Germany, and I am affiliated with the Scalable Visual Computing Group at ScaDS.AI Dresden Leipzig. My research focuses on scientific visualization with data storytelling and exploring its emotional and contextual aspects in different emergent technologies like immersive, tangible, and conversational. My interests lie in investigating how scientific storytelling, which can visualize and narrate extremely complex scientific data, which can be multivariate, spatiotemporal, volumetric, multidimensional, etc., can be transformed into intuitive narratives and visuals, which can then be examined for comprehension and the emotional connection of the data with the user. The focus of my research also lies in inspecting how LLMs can be used to transform the visual narratives of these scientific data stories and how they are different and accurate from the manual narration. Whenever I come across the presentation of complex data for better understanding, the best possible medium I can think of is tangibles, because tangibles are moldable into the form the user likes, and they can be connected with the data in a way that the data can be controlled as well as manipulated. Tangible user interfaces and tangible objects in themselves are a great way of conveying complicated structures in a known format. My motivation behind joining this workshop is to understand how collaboration in tangible user interfaces fosters relations between the users and how LLMs can be a medium to make scientific data storytelling more accessible to people who are new and naive to the domain. I would very much like to employ the learning outcomes of this workshop in my research to understand the co-located collaboration of a user around the data.

Julian Baader. I am a HCI researcher at the Dresden University of Technology and a PhD candidate at the Interactive Media Lab in Dresden, Germany. My research focuses on non-rectangular, non-planar displays and their potential applications in data visualization. I am investigating how interaction techniques, input modalities, and spatial manipulation must adapt when displays move beyond flat, rectangular screens. In particular, I explore what data visualization and embodied interaction might look like in a future where displays take on diverse forms and are embedded throughout the environment. I hope to join the workshop to exchange perspectives, refine these ideas, and explore how emerging devices can support human-human dynamics in everyday settings.

Clara Leidhold. I am a Data Scientist and a PhD candidate at the Image and Signal Processing Group, Leipzig University, Germany, and I am affiliated with the Scalable Visual Computing Group at ScaDS.AI Dresden Leipzig. My research centers on the scientific visualization of high-dimensional, spatio-temporal data and its potential to advance data-driven storytelling in science. I focus particularly on climate data due to its profound societal relevance in the context of global climate change. Effective and affective visual representation and communication are essential not only for raising awareness but also for revealing complex interdependencies within climate systems and making them accessible to broader audiences. Building on this, I am interested in exploring how tangible user interfaces (TUIs) can enable deeper engagement with pressing global challenges such as the climate crisis and how they can contribute to more immersive and participatory forms of data storytelling. A further aspect of my research investigates how trustworthy verbalizations can be generated using large language models (LLMs) and interactively linked to visualizations in order to support interpretability, transparency, and meaningful user interaction. I would be very interested in joining this workshop to learn more about the role of tangible interfaces and their influence on data storytelling processes and exchange ideas on how physical interaction can shape understanding, interpretation, and collaborative meaning-making around complex data.

AI tool compliance

The generative AI tool GPT-5.2 by OpenAI was used to generate the images for the position paper. The prompting was manual, and two to three iterations were done to generate an accurate image to the knowledge of the model. QuillBot was used for grammar and spelling checks.

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