Visual communication in Environmental Health: Methodological Questions and Compromises

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ABSTRACT
Disciplinary differences cause multiple problems with trying to create a research study that gauges readers' comprehension of complex scientific information. This paper provides a case study of the some of the issues associated with research methods and methodologies on an on an interdisciplinary team.

Categories and Subject Descriptors
H.0 Information Systems: General

General Terms
Design, Human Factors,

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Research methods, data visualization, information design

1. INTRODUCTION
For the last four years, I have had been part of several interdisciplinary research teams in environmental health and family and community medicine. While the collaborations have been successful in a variety of ways, they have also been extremely frustrating. In the early years of the collaborations, I thought that most of my frustration was born out of my inexperience in explaining to academics the value that a technical communicator could bring to the projects. But, as weeks, and months, and years past, I realized that the problem was not me and my ability to explain my value; the problem was also not my generous and smart collaborators. The problem was, and is, fundamentally tied to disciplinary training, and more specifically, to training in research methods and methodology.

In this paper, I discuss the root of the research methodological impasse our team encountered and then provide a narrative history of how we worked through some of these methodological problems.

In doing so, I provide a literature review of the work on data visualization and information design and conclude with sketching out the research study design for a multi-site participant comprehension study.

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2. THE ROOT OF METHODOLOGICAL IMPASS
While bordering on an over generalization, one of the fundamental causes of the methodological impasse is the primacy of science and the continuation of the positivist view of world. How academics write vary from discipline to discipline each discipline appeals to their own background knowledge and their own ways of establishing truth [1]. For scientists, the truth-making proposition is the scientific method and the gold standard of clinical trials or large-scale cohort studies. This view is further constructed through the knowledge making enterprise as seen in the publication in peer-reviewed journals.

For technical communicators, the idea that a discipline has its own set of conventions and its own language is not surprising. Rather, our understanding of this fact makes it possible for us to do the jobs we need to do. However, it was not long within the process that I realized I was the only one who understood that different disciplinary communities had different methods and that each research method afforded the research team important insights and should be valued for those contributions. Somewhere along the way in the training of the scientists, any method outside of the scientific method was conceived as less and as something that distracted from the science. Hyland explains this problem through his term the adequacy condition, which means that that claims must be plausible based on the discipline's epistemological framework. Scientists routinely reject statements and claims because those claims fail to meet the minimum level of acceptance within the community. Research methods, particularly qualitative research methods, do not consistently meet the adequacy condition. Searching "qualitative research methods" in Environmental Health Perspectives—one of the top journals in environmental health—will generate eight hits.

Admittedly, boiling down the research methods conundrum to the adequacy condition oversimplifies the situation, but at the same time, it does highlight the fundamental impasse between disciplines. Thus, the big question then is how to overcome this condition and find suitable research methods to answer questions that different disciplines agree are important? In my case study two movements (of sorts) within the broader field of environmental health helped move us forward.

3. POSSIBLE WAY THROUGH THE IMPASSE

Within environmental health, two movements have gained traction over the last several years that seem to indicate a shift in disciplinary thinking: community-based participatory research (CBPR) and an awareness of the ethical role of "reporting back" information to research participants. Similar to Blythe and Grabill's description of participatory action research [2], CBPR is a research framework that emphasizes a bi-directional relationship with the community and research participants where information is shared between the community and academic institution in a mutually beneficial way [3].

Increasingly being used in fields such as public health, health promotion, social work, and environmental health, CBPR allows researchers and community members to have equitable roles in the research process and helps to blur the lines between the researcher and those being researched [4]. The primary benefit of the CBPR orientation is that the research is *with* the community rather than *on* the community. In their landmark environmental health article, O'Fallon and Dearry provided six guiding principles for CBPR that are endorsed by the National Institute of Environmental Health Sciences (NIEHS): prompts active collaboration and participation at every stage of research; fosters co-learning with both researchers and the community contributing expertise; ensures projects are community-driven; disseminates results in useful terms; ensures research and intervention strategies are culturally appropriate; defines community as a unit of identity [5]. In environmental health, scientists and researchers incorporating CBPR in their work are careful to focus solely on the science and the research process rather than on any potential political and cultural issues associated with the research project. By focusing on the science and trying to find scientific answers, this orientation seems to enable long-term participation and often offsets the fears about economic loss for the community. This research orientation is particularly useful when dealing with complicated environmental health problems that require ongoing community participation and buy-in.

Incorporated within the bi-directional relationship of CBPR is the need to provide information to the community, which is often centered on "reporting back" scientific information. Objective facts and scientific results create no "social resonance" as long as they are not communicated back to the participants [6]. In CBPR the need to close the communication circuit with research participants and other community members mandates that scientific information must be and should be reported back to community members, who generally have little background in science. Within the last several years, scientists and researchers in environmental health have been faced with the dilemma of how to report back complex information to research study participants. Thus, the need to be able to communicate complex scientific information clearly becomes a paramount challenge. To help solve the communication problem, environmental health researchers have begun to team up with technical communicators to create informational materials and to research the best methods for reporting back information.

4. DETERMING METHODS

Fundamentally, scientists want their methods to discover and depict reality, while technical communicators understand that the methods chosen enact a certain reality [7]. So how do we bridge the gap? How do we craft a research study design that satisfies the scientists and everyone else?

As we began to approach the study design for reporting back complex information, we knew that there were multiple factors at play. We needed to find the best way to visualize data so that participants could understand it, which we called the data visualization. We also knew that the way that information was presented could potentially effect how well participants understood it, which we called the information design. In this sense, we are using "visualization" to mean how to effectively translate data into visual representations such as bar graphs, scatterplot graphs, bubble charts, or information graphics. We are using "information design" to mean the overall appearance of the page that includes the data visualization, accompanying explanatory text, headings, and other page layout features (in both print and online delivery).

As we began to find out what had been done previously on this topic, we were surprised at the dearth of empirical studies and we were also surprised at the wide range of fields that attempted to study this issue. The research on data visualization and information design is dispersed across a wide range of fields and disciplines, which makes it difficult to build a coherent body of research that could lead to best practices. For example, current studies include psychologists studying the comprehension of bar graphs [8], public health researchers examining cultural data representations [9], and physicians studying how to explain cardiac risk [10,11]. One multidisciplinary review essay [12] attempted to bring together this diverse research, but the authors relied solely on searching two databases, which eliminated the work in the humanities, engineering, and much of the social sciences.

When we narrowed the scope to our two specific fields, the results were not surprising and unfortunately, not helpful. Even though environmental health researchers are concerned with reporting back information, they have yet to generate any substantial work on how best to do it. Adams, et.al produced the first substantial attempt [13], but since they are not trained in technical communication, data visualizations, or usability, their results are limited in application because of the costs involved in producing the information to the levels of "scientific objectivity." Moreover, a member of the research team hand delivered and explained the material to each participant (95), which is cost prohibitive in most studies.

But technical communication has the opposite problem in that much work in technical communication is based on myth, or rather, long standing theories that have rarely been empirically tested with potential audiences [14,15]. A small corpus of work looks at the organization of documents [16, 17], the layout of documents [18), and typography [19, 20, 21].

Two recent examples attempt to design research studies that incorporate testing with potential users. Cain et al.' study began as a test of a finished document and focused on reader reactions to a four-page informational pamphlet about hurricane safety procedures and asked to use the "plus-minus method" to evaluate the text, which involved placing a "+" next to parts that they reacted positively to, and a "-" next to those that elicited negative reactions. The results of this activity and follow-up interviews were then used to recommend changes to the document [22].

Ganier tested users' comprehension and use of instruction manuals in his study, which videotaped 30 participants as they learned to boil potatoes using a prototype pressure-cooker with one of three different manuals (text only, picture only, and text + picture). Participants' use of the instructions and the time it took for them to locate the needed information were tracked. The study

showed that users with the picture + text manual were able to locate the information faster than those with the other manuals, and suggested that procedural documents are not read linearly but selectively, based on the task at hand [23].

The small corpus of work and the fact that none of these studies were similar in research design or findings makes it difficult to argue to those outside of the field and outside of the bounds of disciplinary knowledge that our methods are sound. Pushing against the qualitative bias of scientists, these studies only seemed to support their position that our research methods were not as viable as theirs. It is only when one sees these studies through the eyes of an outsider do one begin to understand the method problems the field of technical communication faces.

So what started out as my attempt to prove that the field of technical communication had something to offer ended up as a quest to understand the ideologies that underscore out current research methods. Perhaps, broad research studies seeking to prove or disprove design principles are not the cure; rather, as Brumberger argues, technical communication needs to abandon such a "formulaic" approach to design [19]. What we need instead, then, is a methodology that is valid and easily replicable and that can be used to test the efficacy of our design decisions, including specific elements of design such as chart and graphs, in the many varied situations in which we must produce texts. Further, that methodology needs, as Zender, et al., point out, meaningful measurements are to determine the success or failure of a particular design or element [24]. But what might this method look like and will this method be something that scientists recognize as rigorous and valid and trustworthy?

5. WHERE DO WE GO FROM HERE?

So with research that was not acceptable to either side, the team was faced with trying to design a research study that met the "standards" of both fields and could have the potential to be replicated in other sites and other projects. What I do know is that the final research study design for the data visualization study will have to be one based on methodological pluralism, which is no single approach is better than others and what is important is that the method be appropriate for the questions under investigation. This rather obvious orientation, however, is important because at its heart methodological pluralism is an attempt to show that no more method is inherently more valid or respectable than others [25].

Since I have been the one that has pushed and argued for this part of the research study to be completed, I determined that one of the most important issues for me has been the ethical impact of methodological decisions. An issue that has consistently concerned me, and one that Barton touches on [26], is the need for research participants to truly understand the research study and its findings. My reorienting my view on research methods to start with ethics first has enabled me to see the project in a much different way. For example, an ethical orientation means

going beyond the standard signing of informed consent, which is really a mechanism for protecting the university rather than the participants, and integrating into the research study design adequate information feedback loops.

One of the greatest strengths of qualitative work (and much of user experience is qualitative) is in its ability to characterize complex situations from multiple perspectives, and in doing so it gives not only a voice but a body to participants [27]. When environmental health scientists discount and/or are skeptical of methods other than scientific methods, research studies run the risk of forgetting the users—the real people—involved in the research. Technical communication has long advocated for the users, and this is one the main reasons that I have continued to work on this project even for all of its frustrations and roadblocks. This ethical obligation to ensure that research participants understand the research and its findings are one of the biggest contributions technical communicators can make.

At this point, the research study design is still not finalized. What we do know is that the data visualization study will incorporate a number of methods that will most likely include eye-tracking, reader response, interviews, focus groups, and surveys. This multi-stage process is guided by St. Amant's RAFT model for image design [28] and Wogalter, et.al, information processing model [29]. Moreover, as I considered the ethical stance that I decided to frame the project, we have expanded the study to include a number of other diverse audiences connected to a variety of research projects (such as Latino/a, urban and rural Appalachians, African-Americans). The aim of expansion was to counter potential critiques of the limitations of the study to one particular participant group and one type of data.

The expansion will allow us to recursively develop, test, and refine our findings, which will ultimately help to prove (or disprove) whether we can develop a best practices or a set of protocols that can be adapted by other environmental health scientists (and those working with complex scientific information). While this method/ology will take longer, it will provide for a large amount of data that can be correlated and should lead us to data saturation and/or having enough information that the majority of readers and participants will understand the information the majority of the time, which are better odds than most findings in scientific studies.

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