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Research Statement

My experience teaching at a public high school sparked my interest in how context shapes student learning, especially in light of students' access to educational technology. I carried through my focus on the roles of context through working in partnership with two fifth-grade teachers to support their students' efforts to engage in modeling scientific and engineering practices, documenting the development of students' thinking and how cooperating teachers negotiated the challenges they faced. This work cemented methodologically what was heretofore a more personal and theoretical commitment to understanding teaching and learning in-context.

As studying teaching and learning in-context requires methodological innovation, particularly when quantitative approaches are used. While I was working to design learning environments and prepare teachers to support students' diagrammatic modeling, I became interested in what educational technology scholars described as an increase in both the amount and kind of data available for use in research. When I was a teacher, I participated in informal weekly meet-ups through a Twitter hashtag associated with my state. This prompted me to study how nearly 70,000 unique user —participated in one or more of the state-based hashtags (Rosenberg, Greenhalgh, Koehler, Hamilton, & Akcaoglu, 2016). This also made me question how students—not just researchers—can use new, widely available data sources in their learning.

Thinking of and with data are important capabilities because work with data integrates across STEM domains: Elements of it appearing in both mathematics and science and engineering curricular reform documents. Also, while many careers that did not once involve thinking of and with data, such as journalism, now do, careers that historically have required work with data now require different tools and processes, namely, computers and computation to process and model data (Nolan & Temple Lang, 2010). These capabilities are also important to learning sciences and developmental psychology scholars (Lehrer & Schauble, 2015). Despite these known benefits, opportunities in K-12 settings for learners to work with data remain very limited. Premised on my experience designing and evaluating learning environments to support diagrammatic modeling and insight into the burgeoning educational data science community, I began to consider the role of students' work with data in the K-12 curriculum. I drew inspiration from science and engineering and mathematics (or STEM) educators' focus on *practices*, goal-directed activities akin to what experts in science, mathematics, and engineering (and computer science) do. Considering that these practices are, to teachers and researchers, both observable and changeable, I chose to focus on two practices in my research, those related to measuring and constructing models of phenomena, such as models helping to explain variation in the measures.

In my dissertation research, I explore how students engage in these practices in out-of-school STEM programs. Much of the research on students' experiences with working with data has traditionally focused on cognitive outcomes or learners' capabilities to participate in specific aspects of data analysis. In contrast, very little is known about learners' experiences of engagement in data analysis and the conditions that support it. I am presently working to develop an understanding of how students engage with data in an approach treats student engagement in the key practices of measuring and modeling as a dynamic, multi-faceted construct. I use an Experience Sampling Method (ESM) whereby learners respond to short survey questions about what they are thinking and doing when signaled. The cutting-edge nature of this work has also led me to develop new analytic tools, such as the *prcr* package for R (statistical data analysis software), to study engagement as a combination of the context and students' characteristics.

I am also working to design and evaluate research-based learning environments and curricular supports that help students use data to understand important phenomena. For example, I worked with instructional designers (and a teacher) from Michigan Virtual School (MVS) to create a unit focused on modeling "messy," real-world data from a simulation about the diffusion of smell (and the kinetic theory of gases). Initial findings from this work suggest that viewing and manipulating the way the simulation worked and needing to consider how to measure the time it took for the smell (molecules) to move—and decide on what model "fits" best—makes it easier for students to understand how the behavior of a gas is the result of the interactions among many individual molecules. In this example and my past research on the *Scientific Practices* project, the research was both design-based and focused on documenting student outcomes.

Over the next five years, my research will focus on developing students' data analysis capabilities in particular areas that should make their experience of working with data easier, namely "wrangling" data. While data are widely available from public and private organizations, much of the time these sources are often provided in a complex, hard-to-use form. Accordingly, many students—and scientists—report that filtering, grouping, summarizing, and the like, take considerable time, while in K-12 settings the core practices of measuring and modeling data from real-world sources remain elusive. My research will focus on developing activities using both traditional classroom materials as well as digital technologies, such as the Common Online Data Analysis Platform (CODAP), designed to make data wrangling more intuitive for learners. While little research has been carried out on the topic, some developmental research suggests learners possess core capabilities that they can build on, such as the ability to classify objects. I will carry out this work as part of ongoing or already-completed studies carried out in partnership with MVS, while other aspects will involve planning and proposing future studies. Another direction for my future work draws from both the design-based work I carry out as well as my dissertation study. Developing opportunities for students to work with data allows, especially when students are using educational technologies, for the creation of large (e.g., big) datasets, which can, in turn, provide new means of documenting engagement. For example, in a new study designed to support not only measuring and modeling data, but also data wrangling, I will use an ESM approach, allowing for better understanding of how particular features of the learning environment and instruction impact how students engage in the different practices.

As data is increasingly used to make decisions for us, students' abilities to think with data and be empowered to—themselves—make decisions are core capabilities in STEM and their lives. Moreover, research about how to think of and with data, and engage in data science practices, suggests a new vision for what more integrated (regarding the knowledge and skills related to science, mathematics, engineering, and technology) STEM learning can become. In conclusion, my work aims to foster an ambitious vision for students' work with data and to contribute to scholarship on STEM teaching and learning. Additionally, my work aims to document student learning and engagement in-context, contributing both applied findings and theoretical accounts to the educational psychology, learning sciences, and developmental psychology fields and practitioners using findings from these disciplines.

References

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