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Title of your paper: Process of refining professional development intervention: Educational design research practices

**Abstract** (245/300 words)

In educational research, it is common practice to report on results of an educational intervention; however, it is rare to report on the process of designing and refining educational interventions. This study uses Educational Design Research to refine a professional learning intervention based on the Consequential Contexts of Data and Statistics (CCDS) framework. CCDS is based on a critical review of data-driven decision-making project conditions in K-12 settings and supports pedagogical practices for teaching statistics. The study asks advisors (e.g., researchers, professional learning facilitators and designers, curriculum designers) to review the handbook and teachers' experience with the designed professional development (PD). The advisors' reviews and the teachers' reflection on the handbook inform how to refine the PD to better prepare teachers to teach statistical and data topics. The study draws upon situated cognition, the statistical knowledge for teaching, intersectionality, and critical statistical literacy theories. The research question guiding the study is: *How does advisor and teacher feedback inform iterative refinements/continuous improvement to the Consequential Contexts of Data and Statistics (CCDS) framework?* The findings of this study offer important insights into design decisions and the iterative process of educational design research.

**Extended summary** (1000/1000 words, excluding reference list)

Despite technological advances, and increased data exposure and production throughout society, technology's dynamic contextualization is not reflected within K-12 education. Resources available to teachers consist of contrived data sets devoid of context and activities requiring students to collect data of no consequence to them (see Weiland, 2019). While a majority of the United States adopted the K-12 Common Core State Standards (NGACBP & CCSSO, 2010), a curriculum that incorporates data and statistics, pre-and in-service teacher education opportunities do not support teachers' SKT (Rossman & Shaughnessy, 2013). The National Council of Teachers of Mathematics is the largest math teacher organization, but at their annual conferences only 3-4% of sessions address statistical standards (Riske, 2020). This is concerning as statistical knowledge is vital for teachers, students, and graduates to make data informed decisions and prepare for career opportunities in statistics, a growing field.

The literature that examines teachers' perceptions, knowledge and development of teaching of statistics is still limited. Some research identifies knowledge required for teaching (see Casey, 2010) and includes frameworks for instruction (e.g., GAISE II, Bargagliotti et al., 2020; SKT, Groth, 2013). However, the studies reveal that both in-service and pre-service teachers face similar struggles around statistical

literacy (Makar & Confrey, 2004; Souza et al., 2015), and teachers do not possess a strong enough background in statistics to allow them to process all the information in some professional development (PD) courses (Schmid et al., 2014). While PDs to improve statistical literacy of teachers exist, many underestimate the scope of the challenge to support educators and may not include knowledge of pedagogy specific for the statistics classroom. Additionally, researchers often do not report on the process of refining their PD interventions or document their design decisions.

### **Research Goals**

Using McKenney and Reeves (2008) Educational Design Research (EDR), the aim of this study is to refine a statistical and data literacy PD intervention through a collaboration with stakeholders in order to understand how educational interventions are developed. The PD is built off the the Consequential Contexts of Data and Statistics (CCDS; Riske, 2021) framework and subsequent PD handbook. CCDS is based on a critical review of literature on data-driven decision-making project conditions in K-12 settings (Riske, 2021). The framework connects students, teachers, data, and the practice of statistics (see Watson & English, 2015) through considering the ethics and context of data as well as the intersecting identities of both students and teachers. This study looks closely at and documents the prototyping of the CCDS handbook and how it can inform professional learning contexts. It relies on advisors to review the handbook and teachers' experience with the designed PD. The research question guiding the study is: *What does advisor and teacher feedback reveal about the potential of CCDS for supporting educators to design experiences for students?*

### **Theoretical Background**

I draw upon situated cognition (Brown et al., 1989), the statistical knowledge for teaching (SKT; Groth, 2013), intersectionality (Crenshaw, 1991), and critical statistical literacy (Weiland, 2017). Since pre-service teaching courses in the United States rarely include SKT, teachers must learn how to teach statistics while teaching (situated cognition). In addition to SKT, teachers need to understand who their students are as individuals and how they learn as students, especially historically marginalized students (see Joseph, 2021). Intersectionality theories highlight the complexity of the human experience with regard to their intersecting and overlapping identities. Critical statistical literacy (Weiland, 2017) advocates critical approaches to statistical information (e.g., data visualizations and collection methods) "to gain an awareness of the systemic structures at play in society" (p. 41). The emphasis on applications within statistical literacy supports the use and critique of data for real-world decision-making as emphasized in SKT.

### **Methods**

To explore the research question, this study draws upon the generic model of EDR (McKenney & Reeves, 2018) and participatory design approach (Bang & Vossoughi, 2016). Hence, this study invites users and stakeholders of the CCDS framework to make adaptations to the design based on their context and needs as learners (Kyza & Georgiou, 2014).

**Participants.** The study includes three participant groups with different functions. Group one includes six advisors with experience in the fields of statistics and mathematics education, professional learning, and critical theory. Advisors critiqued and provided feedback on the handbook. Group two includes ten

K-12 teachers who participated in a 75-minute PD session based on the CCDS framework at a teacher summer institute. Group three includes seven K-12 teachers who teach statistical concepts and possess the classroom dispositions (e.g., value for a growth mindset and social justice topics) the handbook is built upon. Group three participated in three 90-minute PD sessions based on the handbook.

**Data collection and analysis.** Data collected and analyzed included digital artifacts (e.g., teacher written reflections, participant online discussion boards, lesson plans), video-recordings of the PD (e.g., gallery and speaker view on zoom), interviews, and questionnaires (e.g., pre-post teacher survey, feedback form). Data analysis of interviews and surveys employed descriptive (Miles & Huberman, 1994) and apriori coding.

### **Preliminary Findings**

Initial analysis of interviews of the participant groups revealed the following themes with regard to the design decisions for the intervention: (a) opportunities for starting statistical and data literacy in primary school, (b) potential to authentically support students, (c) need for teacher learning schemes with regard to SKT and intersectionality, and (d) finding relevant datasets to the teachers' and students' contexts.

### **Theoretical and Education significance**

The target audience includes researchers in the learning sciences, especially those at the intersections of statistics and teacher education, and educational system designers. The study utilizes situated cognition theories because of the emphasis on teachers as learners (rather than pre-service teachers) so that it can be useful to those teachers in practice and, thus, more likely for teachers to assume ownership and sustain use, which are two dimensions of multi-dimensional scaling.

### **Relevance to QUINT**

This study is relevant to the Quality in Nordic Teaching (QUINT) conference as it seeks to not only develop PD to support teachers' statistical and data literacy but understand how to refine interventions and collaborate among stakeholders.

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