



Online interventions to promote teacher data-driven decision making: Optimizing design to maximize impact

Todd D. Reeves*, Jui-Ling Chiang

Northern Illinois University, United States



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ABSTRACT

Although most schools are steeped in data, many teachers have not had adequate opportunities to learn how to analyze, interpret, and instructionally use data. This paper reports on the efficacy of a suite of online, data literacy interventions for in-service ($n = 25$) and pre-service teachers ($n = 99$). The paper also tests the impact of including pedagogical knowledge and data interpretational scaffolds in such interventions. Findings from two implementations of the interventions indicate changes in in-service and pre-service teachers' data-driven decision making self-efficacy (d s ranged from 0.54 to 0.98) and anxiety (d s were -0.62 and -0.71 respectively), and pre-service teachers' assessment beliefs (d s ranged from 0.23 to 0.62). However, results imply limited value-added effects of scaffolds on the considered outcome variables. Implications for teacher education to support teacher data literacy and data-driven decision making are discussed.

1. Introduction

Teacher education systems are under immense pressure to meet mandates (e.g., those of accrediting bodies, state boards of education) concerning what teachers should know and be able to do upon field entry. Much attention has been directed recently to the expectation that teacher education programs equip future teachers to engage in data-driven decision making (DDDM). The underlying theory of DDDM is that by informing with data decisions related to instructional goals and methods, teachers can better target their instruction to students, ultimately producing higher levels of achievement (Hamilton et al., 2009; Means, Padilla, DeBarger, & Bakia, 2009; Penuel & Shepard, 2016).

DDDM is a complex, multi-faceted, and cyclical process (Coburn & Turner, 2011; Marsh, 2012). Mandinach and Gummer (2016) recently characterized DDDM as having five primary phases: identifying problems and framing questions, using data, transforming data into information, transforming information into a decision, and evaluating outcomes. As DDDM is complex, teacher engagement in these phases requires a sophisticated amalgam of knowledge, skills, and dispositions known as data literacy for teaching (Mandinach & Gummer, 2016). In order to transform data into information, for example, teachers need to be able to understand how to interpret data, and understand and use data displays and representations.

However, studies indicate problems with teachers' data literacy for teaching and resultant implementation of DDDM practices (e.g., Means

et al., 2009; Wayman & Jimerson, 2014). Teachers have been shown to struggle particularly in relationship to interpreting data (Chick & Pierce, 2013; Cowie & Cooper, 2017; Dunn, Airola, Lo, & Garrison, 2013; Means, Chen, DeBarger, & Padilla, 2011; Pierce, Chick, & Gordon, 2013) and implementing instructional changes in response to data (Farrell & Marsh, 2016; Lai & McNaughton, 2016; Marsh, 2012; Marsh, Bertrand, & Huguet, 2015; Schildkamp, Poortman, & Handelzalts, 2016). Breakdowns in either of these processes can undermine DDDM (National Forum on Education Statistics, 2012; Sun, Przybylski, & Johnson, 2016).

At the same time, teacher psychological factors such as attitudes and beliefs constitute potential barriers to DDDM implementation (Cavalluzzo et al., 2014; Prenger & Schildkamp, 2018; Schildkamp, Karbautzki, & Vanhoof, 2014). Teacher self-efficacy and anxiety, in particular, have been shown to respectively facilitate or constrain DDDM (Reeves et al., 2016; Datnow & Hubbard, 2016; Dunn, 2016; Jimerson, Choate, & Dietz, 2015). DDDM self-efficacy has been defined as “teachers' beliefs in their abilities to organize and execute the necessary courses of action to successfully engage in classroom-level DDDM to enhance student performance,” and DDDM anxiety has been defined as “the trepidation, tension, and apprehension teachers feel related to their ability to successfully engage in DDDM” (Dunn et al., 2013, p. 87). About one third of the teachers in Pierce et al.'s (2013) study in Australia indicated that they felt inefficient around data interpretation. Similarly, negative teacher beliefs about the value of

* Corresponding author at: 204A Gabel Hall, Northern Illinois University, DeKalb, IL, United States.
E-mail address: treeves@niu.edu (T.D. Reeves).

data for informing practice and data validity have been documented as DDDM impediments (Means et al., 2011; Oláh, Lawrence, & Riggan, 2010). Problems related to teacher self-efficacy, anxiety, and beliefs concerning DDDM have been observed as early as the preservice stage (Dunn, 2016; Marsh, 2012; Volante & Fazio, 2007).

According to social cognitive theory, self-efficacy and anxiety inhibit the enactment of desired behaviors, such as DDDM (Aydin, Uzuntiryaki, & Demirdög'en, 2011; Bandura, 1988, 1997; Dunn et al., 2013); and beliefs are important theoretical determinants of teaching behavior (Pajares, 1992). With the importance of teacher psychological factors and their malleability in mind (Prenger & Schildkamp, 2018), the present interventional study examined the impact of an intervention on DDDM self-efficacy and anxiety among both pre-service and in-service teachers. Interventions such as that studied here afford both mastery experiences and vicarious experiences, two sources of self-efficacy (Bandura, 1997). In addition, we explored how an intervention relates to pre-service teachers' beliefs about assessment. We opted to focus on the assessment beliefs of pre-service teachers because this population should have formed their beliefs more recently, and it is thus most likely that their beliefs will be amenable to change (Nisbett & Ross, 1980; Rokeach, 1968).

Educational research and practice increasingly focus on interventions by which to promote teacher data literacy and DDDM (Reeves and Chiang, 2017; Carlson, Borman, & Robinson, 2011; Lai & McNaughton, 2016; van Geel, Keuning, Visscher, & Fox, 2016).¹ While the field now knows that it is possible to promote teachers' data literacy and DDDM practices, attention is turning to how to do so most effectively. As such, many have called for further and more rigorous research on teacher education interventions and designs focused on readying teachers in this domain (Hoogland et al., 2016; Turner & Coburn, 2012; Vanhoof & Schildkamp, 2014).

Additional interventional research may be especially important in relation to *pre-service* teachers; research estimates insufficient, superficial, and unevenly distributed opportunities for future teachers to learn how to use data (Bocala & Boudett, 2015; Greenberg & Walsh, 2012; Hamilton et al., 2009; Mandinach & Gummer, 2016; Mandinach & Jimerson, 2016). Moreover, interventions administered *online* may be well positioned to address at scale the limitations of current teacher education practice for data use. Online interventions may provide access to expertise not available locally for all pre- or in-service educators, in addition to being potentially more convenient and cost-effective (Reeves and Pedulla, 2011; Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2009).

2. The present study

This paper reports on the efficacy of a related suite of four online data literacy interventions, implemented with in-service ($n = 25$) and pre-service teachers ($n = 99$). Throughout this manuscript, "online" refers to the delivery mode of the interventions (c.f. face-to-face interventions). In particular, the interventions were asynchronous (meaning that participants did not need to log on at the exact same time as the other participants or the instructors). The facilitated, collaborative, and highly-structured interventions engaged participants in asking and answering four different kinds of questions (e.g., achievement status and growth, strengths and weaknesses) at five different student levels (e.g., individual, subgroup, school) with external, standardized assessment data presented in tables, charts, and score reports. We chose to focus on achievement assessment data given their ubiquity in schools and their centrality to the work of schooling. We focused on external, standardized assessment data given the unique challenges associated with use

of these types of data. Teachers generally view such data negatively on account of their timeliness, grain size, and instructional utility (Dunn, 2016; Farrell & Marsh, 2016; Ingram, Louis, & Schroeder, 2004), and such data are often reported in complex ways (e.g., as scale scores with corresponding standard errors, or standard scores, amidst normative data).

All four interventions were derived from an intervention entitled Data in Five by Four ($D5 \times 4$), which was originally implemented with in-service and pre-service teachers concurrently (Reeves and Chiang, *in review*). In this study, the $D5 \times 4$ intervention or a variation thereof was offered to in-service and pre-service teacher populations separately. Herein two $D5 \times 4$ interventions for in-service classroom teachers focused on use of student data in language and literacy; and two $D5 \times 4$ interventions for pre-service classroom teachers focused on use of student data in all four core subject areas.

The paper also tests the value-added effects of two design variations for these $D5 \times 4$ interventions. One design variation was targeted to in-service teachers and involved the inclusion of pedagogical knowledge scaffolds (which took the forms of an instructional resource guide and coaching from subject-matter experts). The other design variation was targeted to pre-service teachers and involved the inclusion of data interpretational scaffolds (which took the form of data exhibit annotations). Altogether, this study reports on the outcomes of four $D5 \times 4$ interventions: in-service teacher interventions with and without pedagogical scaffolds, and pre-service teacher interventions with and without data interpretational scaffolds. The preceding Theoretical Framework rationalizes the scaffolds.

This study primarily directs attention to these interventions' efficacy in relation to teacher psychological outcomes. However, we also collected evidence of growth in in-service teachers' data use practices as well as in-service and pre-service teacher' perceptions of their skill development during $D5 \times 4$. The research questions were: (1) To what extent do *in-service teachers'* DDDM self-efficacy, anxiety, and implementation of data use practices change during the intervention (and do any changes vary as a function of scaffolds)?; (2) To what extent do *pre-service teachers'* DDDM self-efficacy, anxiety, and beliefs about assessment change during the intervention (and do any changes vary as a function of scaffolds)?; (3) What are in- and pre-service teachers' perceptions of the impact of the intervention (and do perceptions vary as a function of scaffolds)?; and (4) What are in- and pre-service teachers' perceptions of the scaffolds?

In answering these research questions, the present study seeks to accomplish two primary aims. The first aim is to replicate prior findings about $D5 \times 4$'s efficacy in contexts in which only a single population participates in the intervention (as opposed to co-mingling distinct populations). The second aim is to extend research on the optimal design of data literacy interventions by comparing the effectiveness of similar but systematically-different interventions.

3. Theoretical framework

Mandinach and Gummer (2016) recently theorized that engagement in each of the five phases of DDDM requires a specific body of knowledge and skills (i.e., data literacy). The interventions described here primarily targeted teacher data literacy within the DDDM domains of *transforming data into information* and *transforming information into a decision* (Mandinach & Gummer, 2016). These two phases constituted the primary targets of these interventions because of research-based evidence for teacher challenges in these realms (Marsh, 2012; National Forum on Education Statistics, 2012).

3.1. Transforming data into information

A critical DDDM phase is *transforming data into information*, which requires that teachers understand how to interpret data, and understand and use different data displays and representations (Mandinach &

¹ Data-driven decision making in education is not immune to critique, however, relative to both its theory of action and possible unintended consequences in practice (Neuman, 2016; Penuel & Shepard, 2016).

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