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LEARNING, INSTRUCTION, AND COGNITION

Becoming Data Driven: The Influence of Teachers' Sense of Efficacy on Concerns Related to Data-Driven Decision Making

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Data-driven decision-making (DDDM) reform has proven to be an effective means for improving student learning. However, little DDDM reform has happened at the classroom level, and little research has explored variables that influence teacher adoption of DDDM. The authors propose a model in which teachers' sense of efficacy for the skills that support classroom-level DDDM and DDDM anxiety significantly influenced teachers' DDDM efficacy, which then influenced collaboration concerns that influenced refocusing concerns. The authors used structural equation modeling to analyze data on 537 teachers in order to validate this hypothesized model. Results supported this model and are discussed.

Keywords *motivation, self-efficacy, survey research, teacher preparation, teaching*

RECENT EMPHASIS ON DATA-DRIVEN DECISION MAKING (DDDM) has resulted in a vast body of research elucidating the power of DDDM for school, classroom, and student improvement. DDDM refers to systematic collection and use of many forms of data from a variety of sources in order to improve student performance (Choppin, 2002; Marsh, Pane, & Hamilton, 2006). DDDM is more than a system for accountability; at the classroom level, DDDM is a learner-centered teaching tool that supports differentiated instruction by providing information that helps teachers tailor instruction to fit class and individual learning needs (Rallis & MacMullen, 2000).

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In other words, teachers use data to determine who requires remediation, who needs grade-level support, and who needs enrichment. For example, to address the reading needs of sixth-grade learners, the teacher must first identify the appropriate grade-level screening test, access the appropriate results, interpret the results by identifying student strengths and weaknesses, and apply that information to an instructional plan. Thus, for a teacher to successfully use data to change student outcomes, he or she must be technologically, statistically, and pedagogically savvy.

Thus, a major challenge for data-focused educational reform is the identification and implementation of effective professional development practices that lead to transformed instruction (U.S. Department of Education, Institute of Education Sciences, 2009). However, the chain of inferences from teacher use of data systems, to teacher data analysis, to changed instruction, and to improved student outcomes is currently weak (U.S. Department of Education, Institute of Education Sciences, 2009). Furthermore, research related to the change process associated with teacher adoption of DDDM practices is almost nonexistent.

Another issue that must be highlighted is that teachers are underprepared to engage in effective DDDM practices (e.g., Bernhardt, 1998; Choppin, 2002; Volante & Fazio, 2007; Wayman, 2005). As a result, states, districts, and schools are devoting increasing amounts of time and money to DDDM professional development (U.S. Department of Education, Institute of Education Sciences, 2008). Thus, the training and development of data-literate teachers capable of effective DDDM represents a timely and essential area of research that must be expanded if an expectation for increased student achievement through teacher DDDM is to be realized. Two previously unexplored variables that are critical to expanding our understanding of teacher adoption of DDDM and effective DDDM professional development are DDDM efficacy and DDDM concerns.

Teachers' sense of efficacy for DDDM (DDDM efficacy) was defined as teachers' beliefs about their abilities to successfully engage in classroom level DDDM (Dunn, Airola, Garrison, & Nickens, 2011). Teacher anxiety is an inverse indicator of efficacy (Aydin, Uzuntiryaki, & Demirdogen, 2011) and commonplace in teachers faced with DDDM reform efforts (Samuel, 2008); thus, it was examined as a component of DDDM efficacy. DDDM anxiety was defined as the worry, tension, and apprehension teachers feel about engaging in DDDM (Dunn et al., 2011). Teacher concerns refer to one's set of thoughts and feelings about an innovation that include perceptions, preoccupations, considerations, contentment, and frustration (Hall & Hord, 2011). In this study, the target innovation was DDDM. We assessed efficacy and concerns at corresponding task levels to adhere to the recommendation that variables be measured at similar levels of specificity in order to ensure accuracy of interpretations related to statistical analyses (Bandura, 1997; Pajares, 1996; Pintrich & Schunk, 1996).

The purpose of this study was to examine the influence of teachers' DDDM efficacy on teachers' impact-level concerns regarding implementation of DDDM in the classroom in order to gain a better understanding of the change process associated with teacher adoption of DDDM practices. Impact-level concerns are the highest level of concerns and are indicative of teacher engagement in a target innovation (George, Hall, & Stiegelbauer, 2006; Hord & Hall, 2011). The teachers who were studied were involved in a statewide DDDM initiative supported by intense, targeted professional development efforts. Empirical evidence supported that teachers' efficacy beliefs are powerful predictors of teacher action (Fives, 2003; Tschannen-Moran & Woolfolk-Hoy, 2001). Moreover, efficacy beliefs influence one's thoughts and emotions (Bandura, 1986, 1993, 1997). Because concerns are comprised of thoughts and emotions, teacher efficacy may significantly influence teacher concerns. Although there is some evidence that teachers' sense of efficacy affects teachers' concerns (Dunn & Rakes, 2010; Charalambous & Philippou, 2010; McKinney, Sexton, & Meyerson, 1999; Newman, Moss, Lenarz, & Newman, 1998), there is a scarcity of research that examines the influence of teachers' DDDM efficacy on teachers' DDDM concerns. We hypothesized that teachers' DDDM efficacy would significantly and positively influence teachers' concerns about DDDM.

THEORETICAL FRAMEWORK

Social learning theory serves as the theoretical framework for this study. In particular, the self-system that resides in the cognitive component of Bandura's (1978) model of reciprocal determinism serves as the theoretical foundation for this study. In reciprocal determinism, cognitive, behavioral, and environmental factors serve as mutual determinants of one another. The ebb and flow of each component of this triadic model influences the other components and vice versa. In the cognitive node of this model, Bandura (1978) discussed the microcosm of the self-system. The self-system comprises perceptions, thoughts, and beliefs that are the structures of cognition, such as efficacy and concerns. Similar to the larger model in which the self-system resides, we proposed that teachers' efficacy for various tasks and concerns regarding those tasks interact, and subsequently affect the other nodes in the model of reciprocal determinism. In particular, efficacy beliefs affect the way one thinks and feels (Bandura, 1986, 1993, 1997), and because concerns are comprised of thoughts and feelings about a target innovation, we proposed that teachers' efficacy beliefs will directly inform teachers' concerns about an innovation.

Teacher Sense of Efficacy

Bandura (1997) defined *efficacy* as a self-reflective, future-oriented belief that one possesses the necessary skill set to successfully accomplish a task. Thus, teachers' sense of efficacy reflects their belief that they can bring about positive student outcomes (Charalambous, Philippou, & Kyriakides, 2008; Tschannen-Moran & Woolfolk-Hoy, 2001). Individuals' beliefs about how well they will or will not perform profoundly affect their pattern of thought, emotion, and behavior. If a teacher believes he or she will be successful at a task, the task is more likely to elicit a positive affective response from the teacher (Bandura, 1986, 1993). As a result of these positive beliefs, thoughts, and feelings in the self-system, it is more likely that individuals will be open to adopting new innovations (Ghaith & Yaghi, 1997; Gordon, Lim, McKinnon, & Nkala, 1998; Straub, 2009) and will persist when confronted with obstacles to innovation use in the classroom (Bruce, Esmonde, Ross, Dookie, & Beatty, 2010; Cousins & Walker, 2000).

Researchers have identified a number of teacher characteristics that are affected by teachers' sense of efficacy; these characteristics are similar to a number of issues that may hinder teacher engagement in DDDM. In particular, researchers have reported that teachers' sense of efficacy affects teacher stress (Schwarzer & Hallum, 2008), persistence at a task in the face of obstacles (Bruning, Schraw, & Ronning, 1999), and innovation use in the classroom (Cousins & Walker, 2000). Teachers' sense of efficacy has also been found to affect pedagogical decision making (Woolfolk et al., 1990). Czerniak (1990) found that highly efficacious teachers are more likely to use learner-centered teaching strategies in lieu of more teacher-centered strategies. Teacher-centered instructors with low efficacy fail to adjust to the individual needs of students, a concept at the heart of DDDM (Rallis & MacMullen, 2000).

These research findings emphasize the importance of investigating efficacy with regard to teacher DDDM, as DDDM is a learner-centered practice that is often novel to teachers and stress inducing (Rallis & MacMullen, 2000; Samuel, 2008). Moreover, teachers' limited understanding of statistics, data systems, and relevant DDDM technology as well as low levels of confidence with regard to engaging in DDDM present daunting obstacles to implementation of DDDM practices (Volante & Fazio, 2007; Wayman, 2005).

In this study, we examined teachers' sense of efficacy for DDDM, or DDDM efficacy, in accordance with the recommendation that efficacy be explored at the task-specific level (e.g., Bandura, 1997; Pajares, 1996). DDDM efficacy was defined as a teacher's beliefs in his or her ability to successfully engage in classroom level DDDM in order to amplify student learning (Dunn et al., 2011). During the training that teachers in this study received, classroom level DDDM was defined as the use of a variety of data (e.g., state-mandated exams, formative assessments) to adjust instruction in order to improve learning for all students. In particular, classroom level DDDM was viewed as involving the identification of patterns of performance that reveal students' strengths and weaknesses relative to students' learning goals and selecting instructional strategies and specific interventions to facilitate students reaching appropriate learning goals (Dunn et al., 2011).

In addition to exploring teachers' sense of efficacy for classroom level DDDM, we explored three critical efficacy-related components—efficacy for data access and identification, efficacy for data tool and technology use, and anxiety for DDDM. First, efficacy for data access and identification reflects teachers' confidence for a skill that Stiggins (2001) described as critical to DDDM, the ability to access and gather dependable, high-quality student data. It is also imperative that teachers understand how to use their districts complex data technology resources (Wayman & Cho, 2008). Therefore, this study also explored teachers' sense of efficacy for data tool and technology use, which was defined as teachers' confidence in their ability to successfully use district data technology resources. Last, research strongly supports that anxiety shares an inverse predictive relation with efficacy (e.g., Aydin et al., 2011; Bandura, 1988; Gresham, 2009; Hoffman, 2010). Moreover, DDDM reform efforts often induce anxiety in teachers (Samuel, 2008). In accordance with extant literature on statistics anxiety (Williams, 2010; Zeidner, 1991), DDDM anxiety was defined as the worry, tension, and apprehension teachers feel related to their ability to successfully engage in DDDM (Dunn et al., 2011). In addition to its relation to efficacy, anxiety, even at moderate levels, may also impede teacher adoption of innovations (Learner & Timberlake, 1995).

Teacher Concerns

Similar to efficacy and anxiety, teacher concerns may either serve to impede or facilitate the adoption of innovations and related practices. Hall, George, and Rutherford (1979) defined concerns as a "composite representation of the feelings, preoccupations, thought, and consideration given to a particular issue or task" (p. 5). Hall and his colleagues noted that concerns generally follow a hierarchical pattern through seven stages of concern that are organized into three developmental tasks—self, task, and impact (George et al., 2006; Hall & Hord, 1987, 2011). The seven stages of concern are indicative of one's willingness to adopt a new innovation (Charalambous & Philippou, 2010; Scott, 1998). Higher level concerns are indicative of adoption of a new innovation where as lower level concerns are more indicative of resistance or unpreparedness to adopt a new innovation (George et al., 2006; Hall & Hord, 2011). This study explored higher level impact concerns because they are more closely associated with engagement in an innovation.

The impact level of concerns includes three stages of concern—consequence, collaboration, and refocusing. In this level, teachers move from being concerned about the effect of innovation related practices on students (consequence) to being concerned about working with their colleagues to refine their innovation related practices (collaboration). Last, teachers begin to consider how to revise, improve, or adapt the innovation (refocusing). For the purposes of this study, the two most mature levels of concerns were examined and served as proxies for DDDM engagement (collaboration and refocusing). Stage 5—Collaboration Concerns indicate one has adopted an innovation. These concerns pertain to working with colleagues in order to increase and improve implementation of the target innovation. Stage 6— Refocusing Concerns further reflect engagement in an innovation as well as interest in adapting or revising an innovation based on student reactions and results of implementation (George et al., 2006; Hall & Hord, 1987, 2011). Identifying an individual's level of concern relevant to a target innovation may assist in facilitating change (Hall & Hord, 2011; Negrete, 2004). Therefore, by identifying teacher characteristics that influence higher level concerns, those involved in professional development efforts may increase teacher adoption of classroom-level DDDM.

Teachers' Sense of Efficacy and Concerns

Efficacy beliefs influence one's thoughts and emotions (Bandura, 1986, 1993, 1997), which, in turn, comprise teacher concerns (Hall & Hord, 2011). Research supports the existence of a relation between teachers' sense of efficacy and teacher concerns (e.g., Dunn et al., 2011; Charalambous & Philippou, 2010). However, dissonance exists in the literature with regard to the nature of this relationship. The majority of the literature supports that the two variables share a positive relationship (Dunn et al., 2011; Dunn & Rakes, 2010; McKinney et al., 1999; Newman et al., 1998). For example, McKinney and her colleagues (1999) found that teachers with higher levels of efficacy reported higher level concerns with regard to the adoption of whole language instructional reform ($n = 101$). However, Charalambous and Philippou (2010) found that for elementary mathematics teachers who were asked to adopt a reformed math curriculum, teachers with higher efficacy reported lower levels of impact concerns ($n = 151$). Understanding the relationship among these variables is important to those working towards the goal of teacher adoption of new innovations. Although most of the literature supported the relationship that McKinney and colleagues (1999) found, the contradictory evidence provided by Charalambous and Philippou (20101) supported the need to further explore the relationship between efficacy and concerns. Impact concerns are indicative of innovation use (George et al., 2006; Vaughan, 2002); thus, the conflicting findings about the manner in which efficacy influences these beliefs provides another example of the need for this study to support DDDM reform-focused teacher professional development efforts. DDDM efficacy and DDDM concerns were selected not only for the aforementioned research-based reasons and the theoretical chain of inferences but also because efficacy (Bandura, 1997; Burton, Bamberry, & Harris-Boundy, 2005) and concerns (George et al., 2006) may be improved through targeted training.

When an individual's stage of concern is examined with regard to his or her level of self-efficacy, one may better understand the effects of and facilitate the change process (Charalambous & Philippou, 2010; Ghaith & Shaaban, 1999; McKinney et al., 1999; Newman et al., 1998). However, no research has investigated the relationship between DDDM efficacy and DDDM concerns. Thus, this study investigated the influence of DDDM efficacy on teachers' Impact Concerns regarding implementation of DDDM. If teachers' DDDM efficacy directly informs impact concerns related to DDDM and is also a malleable teacher characteristic, it may be possible to help advance teachers' concerns, and subsequently, their engagement in DDDM through targeted DDDM efficacy training. This study explored the influence of DDDM efficacy on teachers' impact-level concerns regarding the implementation of DDDM practices. Such research is important in light of current requirements for and emphasis on teacher engagement in DDDM as well as the positive effect of classroom-level DDDM on student outcomes (Armstrong & Anthes, 2001; Schuerich & Skrla, 2003).

Most research conducted over the course of the past 20 years has examined the mutual relationship between teachers' sense of efficacy and concerns (e.g., Dunn et al., 2011; Ghaith & Shaaban, 1999; McKinney et al., 1999; Newman et al., 1998). Charalambous and Philippou (2010) proposed that researchers consider exploring the unidirectional or causal influence of teachers' sense of efficacy on teacher concerns through structural equation modeling. On the basis of this suggestion and the empirical evidence discussed earlier, we hypothesized that teachers' sense of efficacy for the skills that support classroom-level DDDM (i.e., data access and identification; data tool and technology use) and DDDM anxiety would significantly influence teachers' sense of efficacy for classroom-level DDDM (i.e., DDDM efficacy). We also hypothesized that DDDM efficacy would significantly influence collaboration concerns. Last, we hypothesized that because of the hierarchical developmental nature of concerns (Hall & Hord, 2011), collaboration concerns would significantly influence refocusing concerns (see Figure 1). The purpose of this study was to validate the proposed model linking DDDM efficacy beliefs and teacher DDDM impact concerns.

The research questions for this study were as follows. To what extent do DDDM efficacy and teacher concerns support a model in which

1. Efficacy for data identification and access; efficacy for data technology use; and DDDM anxiety inform DDDM Efficacy, as measured by the efficacy for data interpretation, evaluation, and application subscales on the DDDM Efficacy (3D-ME) Inventory?
2. DDDM Efficacy informs teachers' Stage 5—Collaboration Concerns, as measured by the SoCQ?
3. Teachers' Stage 5—Collaboration Concerns inform teachers' Stage 6—Refocusing Concerns, as measured by the SoCQ (see Figure 1)?

METHOD

To explore the validity of this model, we used structural equation modeling to analyze participants' responses to two online questionnaires: the 3D-ME and the SoCQ. The 3D-ME consists of four subscales: (a) efficacy for data identification and access; (b) efficacy for data technology use; (c) efficacy for data interpretation, evaluation, and application; (d) and DDDM anxiety. This

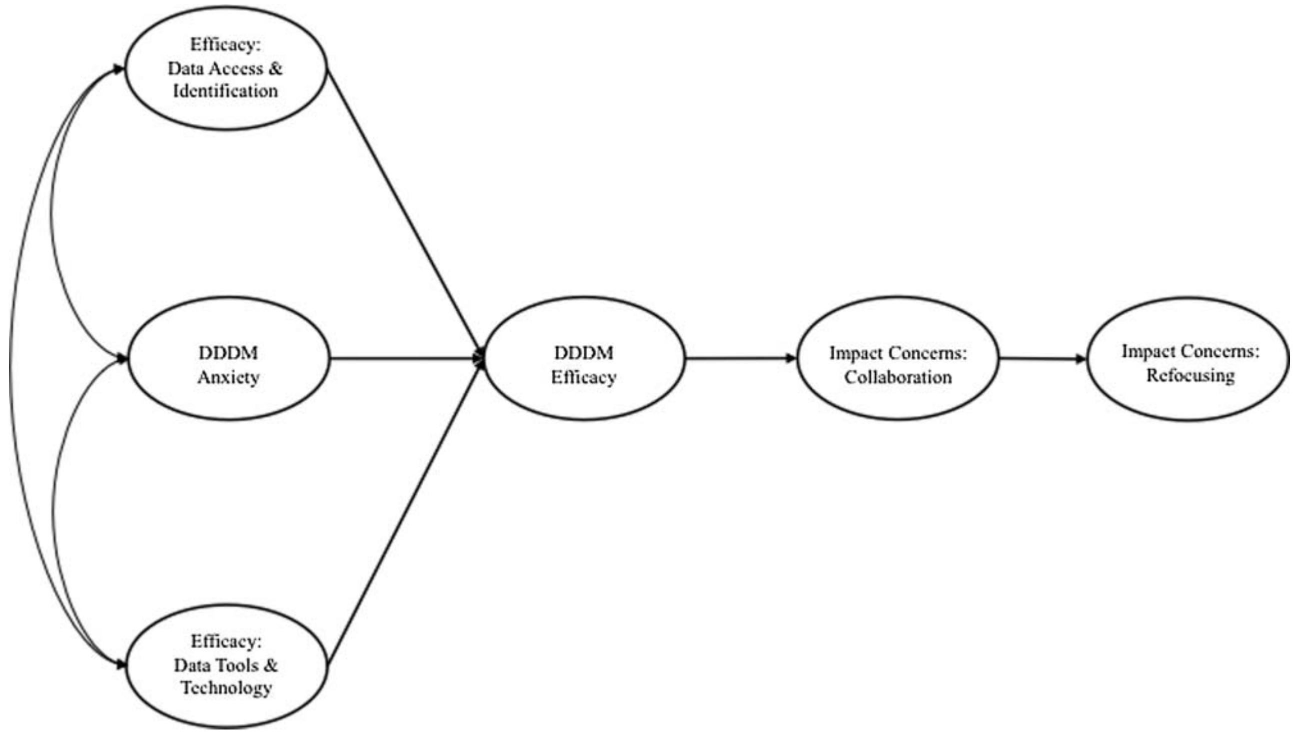

FIGURE 1 Hypothesized model of DDDM efficacy and concerns.

research used two of the SoCQ scales that assessed impact concerns: Stage 5—Collaboration Concerns and Stage 6—Refocusing Concerns.

Participants

Kindergarten through 12th-grade teachers in a northwestern state who had undergone intense seminar and job-embedded DDDM professional development were asked to participate in this study and to respond to two online questionnaires by e-mail, the 3D-ME and the SoCQ; 537 teachers responded. The sample consisted of 34% men ($n = 245$) and 66% women ($n = 355$). Participants presented a wide array of ages: 20–29-year-olds (14%), 30–39-year-olds (25%), 40–49-year-olds (25%), 50–59-year-olds (30%), and 60 years or older (6%). The majority of teachers had 1–9 years of experience in their current role (57%). The remaining teachers reported the following with regard to years of experience in their current role: less than 1 year comprised 14%, 10–20 years comprised 20%, 20–29 years comprised 7%, and 30 or more years comprised 2%.

Measures

3D-ME

We designed the 3D-ME Inventory to assess teachers' sense of efficacy for DDDM to inform job-embedded professional development efforts (Airola & Dunn, 2011). Teacher DDDM efficacy reflects teachers' beliefs in their ability to successfully engage in DDDM. The 3D-ME Inventory consisted of 20 items, used a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), and included four subscales: (a) efficacy for data identification and access (three items); (b) efficacy for data technology use (three items); (c) efficacy for data interpretation, evaluation, and application (nine items); and (d) DDDM anxiety (five items, reverse coded). Items are listed in Table 1.

The efficacy for data identification and access subscale assessed teacher confidence in the ability to access and gather reliable, high-quality student data. The efficacy for data technology use subscale assessed teacher confidence in the ability to successfully navigate and use data systems and data tools. The efficacy for data interpretation, evaluation, and application subscale assessed teacher confidence in the ability to effectively engage in classroom-level DDDM, using data to make instructional decisions to improve student learning. The DDDMA scale measured teacher anxiety associated with DDDM, an inverse measure of general DDDM confidence.

The 3D-ME Inventory were initially validated on a large sample of in-service teachers ($N = 1{,}777$). We used exploratory and confirmatory factor analyses, respectively, to establish four factors of the 3D-ME Inventory (Airola & Dunn, 2011). The discriminant validity of the 3D-ME was established at two levels—between scales and between efficacy measures. Interfactor correlations indicated the factors were correlated at the small to moderate level ($.26 \leq r \leq .47$), well below the .80 level established as an upper bound by Campbell (1960) for discriminant validity between scales.

Oblique rotation resulted in a four-factor solution. With the exception of Item 1, the ranges for the coefficients for each scale were acceptable and supported the hypothesized scales (Costello & Osborne, 2005). Item 1 was retained to maintain internal consistency reliability for Scale 1, as

TABLE 1
Means and Standard Deviations for SoCQ and 3D-ME ($N = 537$)

Scale	*Variable (Item)*	*Description*	M	SD
SoCQ: Stage 5	1 (5)	I would like to help other faculty in their use of the innovation.	3.23	2.11
	2 (10)	I would like to develop working relationships with both our faculty and outside faculty using the innovation.	4.00	1.99
	3 (18)	I would like to familiarize other departments or persons with the progress of this new approach.	3.09	2.08
	4 (27)	I would like to coordinate my effort with others to maximize the innovation's effects.	4.69	1.95
	5 (29)	I would like to know what other faculty are doing in this area.	4.68	192
SoCQ: Stage 6	6 (2)	I now know of some other approaches that might work better.	3.03	2.02
	7 (9)	I am concerned about revising my use of the innovation.	2.75	1.89
	8 (20)	I would like to revise the innovation's instructional approach.	2.38	1.91
	9 (22)	I would like to modify our use of the innovation based on the experiences of our students.	3.72	2.09
	10 (31)	I would like to determine how to supplement, enhance, or replace the innovation.	3.41	2.09
3D-ME: EDIA	11(1)	I am confident in my ability to access state assessment results for my students.	3.72	1.07
	12 (2)	I am confident that I know what types of data or reports I need to assess group performance.	3.60	0.98
	13 (3)	I am confident that I know what types of data or reports I need to assess student performance.	3.69	0.96
3D-ME: EDTU	14 (4)	I am confident I can use the tools provided by my district's data technology system to retrieve charts, tables or graphs for analysis.	3.31	1.09
	15 (5)	I am confident I can use the tools provided by my district's data technology system to filter students into different groups for analysis.	3.24	1.11
	16 (6)	I am confident that I can use my district's data analysis technology to access standard reports.	3.34	1.07

(Continued on next page)

TABLE 1
Means and Standard Deviations for SoCQ and 3D-ME ($N = 537$) *(Continued)*

Scale	*Variable (Item)*	*Description*	M	SD
3D-ME: EDIEA	17 (7)	I am confident in my ability to understand assessment reports.	3.89	0.80
	18 (8)	I am confident in my ability to interpret student performance from a scaled score.	3.60	0.94
	22 (12)	I am confident that I can use assessment data to provide targeted feedback to students about their performance or progress.	3.80	0.87
	23 (13)	I am confident I can use assessment data to identify gaps in my instructional curriculum.	3.79	0.85
	24 (14)	I am confident that I can use data to group students with similar learning needs for instruction.	3.88	0.80
	25 (15)	I am confident in my ability to use data to guide my selection of targeted interventions for gaps in student understanding.	3.73	0.85
3D-ME: DDDMA	26 (16)	I am intimidated by statistics.	3.61	1.13
	27 (17)	I am intimidated by the task of interpreting students' state level standardized assessments.	3.61	1.06
	28 (18)	I am concerned that I will feel or look "dumb" when it comes to data driven decision making.	3.70	1.08
	29 (19)	I am intimidated by my district's data retrieval technology.	3.52	1.07
	30(20).	I am intimidated by the process of connecting data analysis to my instructional practice.	3.62	1.02

Note. Data-based decision making scale was reverse-coded. SoCQ items were taken from Hall, George, and Rutherford (1979). Stages of Concern Questionnaire (SoCQ). Data Driven Decision-Making Efficacy (3D-ME). 3D-ME subscale abbreviations: Efficacy for Data Identification and Access (EDIA); Efficacy for Data Technology Use (EDTU); (c) Efficacy for Data Interpretation, Evaluation, and Application (EDIEA); and (d) Data Driven Decision-Making anxiety (DDDMA).

its standardized regression coefficient of .38 was close to the lower bound of .40. Factor loadings for the scales ranged from .38 to .66, .80 to .84, .59 to .80, and .64 to .83, respectively.

We used the Teachers' Sense of Efficacy Scale (Tschannen-Moran & Woolfolk-How, 2001) to establish discriminant validity, as no existing measure was available to establish convergent validity. Correlation coefficients for this scale and for the 3D-ME ranged from –.02 to .27, which established the discriminant validity of this measure of DDDM efficacy from a more general measure of teachers' sense of efficacy for teaching. Test–retest reliability was established on a sample of 157 teachers and, for each of the 3D-ME subscales, it ranged from .70 to .80 (Airola & Dunn, 2011).

Using Cronbach's alpha, we assessed internal consistency reliability for the 3D-ME (Crocker & Algina, 1986; Cronbach, 1951). Within-scale internal consistency statistics were all above .84. Internal consistency across the four subscales was .73. Cronbach's alphas for the four subscales of the 3D-ME were .84, .91, .92, and .89, respectively. Internal consistencies exceeded Nunnally's (1967) cutoff criterion of .60 and were deemed acceptable.

SoCQ

The SoCQ was developed as a tool to identify the intensity of teacher concerns and has been used for more than 30 years with acceptable reliability and validity (George et al., 2006). The information gleaned from this questionnaire helps to identify an individual's willingness to adopt and use an innovation (Scott, 1998). The survey consisted of 31 items and an 8-point Likert scale ranging from 0 (*not true of me now*) to 7 (*very true of me now*) used to measure the seven scales associated with the seven stages of concern (Hall & Hord, 1987). For this study, only the two scales that assess the most mature concerns were used: Stage 5—Collaboration Concerns (five items) and Stage 6—Refocusing Concerns (five items). Items are listed in Table 1.

Hall, George, and Rutherford originally validated the SoCQ in 1979 on a sample of 830 teachers. Cronbach's alpha was used to establish internal reliability and ranged from .64 to .83 in the original study. A subsample of the original respondents participated in a test–retest study of the instrument. The test–retest correlation ranged from .65 to .84. The initial findings indicated that the measure was stable. Since the initial validation of the SoCQ, many researchers have confirmed the reliability and validity of the SoCQ (e.g., George et al., 2006; James & Lamb, 2000; O'Sullivan & Zielinski, 1988; Rakes & Casey, 2002). In the present study, we established internal consistency for the SoCQ using Cronbach's alpha. Cronbach's alpha for the Stage 5—Collaboration Concerns and Stage 6—Refocusing Concerns scales were .80 and .71, respectively.

Analyses

On the basis of a confirmatory factor analysis framework, we used EQS 6.1 (Bentler, 2006) to identify potentially relations between teacher efficacy and concerns and to test the plausible hypothesized model (see Figure 1) with the raw data imported from SPSS 19. To investigate the goodness-of-fit indices of the hypothesized confirmatory factor analysis model, we evaluated the chi-square statistic, the comparative fit index, the standardized root mean square residual, and the root mean square error of approximation, with Hu and Bentler's (1999) recommendation.

RESULTS

The means and standard deviations of each item from the SoCQ and 3D-ME are presented in Table 1. Following descriptive analysis, the initial hypothesized model was fit to the covariance matrix using robust maximum likelihood in EQS. Although the chi-square statistic is the most widely used index to examine the adequacy of model fit, it has the well-known problem of tending to overestimate lack of fit if the sample size is large (Millsap, 2007). Therefore, as suggested by Hu and Bentler (1999), several approximate fit indices have been used and the following criteria were used to indicate good data-model fit: above .95 for comparative fit index, below .08 for standardized root mean residual, and below .06 for root mean square error of approximation.

The chi-square statistic, as expected, was significant, χ^2 (397) = 934.079, $p < .001$. The results of other fit indices indicated the initial hypothesized model had a good approximated fit to the observed data (comparative fit index = .934, standardized root mean residual = .058, root mean square error of approximation = .054 and 90% CI = .049 to .058). Therefore, this proposed model is our final model, and it is not necessary to use the modification index to improve the model fit. The standardized solution of all path loadings is significant ($p < .05$) and shown in Figure 2.

DISCUSSION

DDDM is an educational reform that goes far beyond standardized summative testing. In fact, when enacted properly, DDDM should affect teachers' classroom decision making and subsequently student success. However, little research examines the key change agents in this reform movement, teachers, beyond noting that they are unprepared to engage in DDDM (Choppin, 2002; Wayman, 2005). This unfortunate caveat may add to the negative stigma associated with DDDM. Also, large amounts of time and money have been spent to increase teacher knowledge in order to increase teacher DDDM. However, learning involves far more than simple acquisition of knowledge because learning is a change in behavior that results from a complex change process (Schunk, 2001). The purpose of this study was to add to the limited literature that explores the change process associated with teacher adoption of DDDM. To do so we developed and validated a model integrating teachers' sense of efficacy beliefs regarding DDDM and underlying components of DDDM as well as DDDM concerns. In this section, we discuss the limitations and findings, propose implications for practice and policy, and offer future directions for research.

Research Findings and New Insights

We hypothesized that teachers' sense of efficacy for foundational aspects of DDDM (i.e., identifying and accessing data; using data tools and technology) and DDDM anxiety would significantly influence teachers' DDDM efficacy, which would, in turn, influence teachers' collaboration concerns about DDDM. It was subsequently hypothesized that teachers; collaboration concerns would significantly influence teachers' refocusing concerns about DDDM. This initial proposed model was validated in this study and offered new insight to efficacy and concerns literature, and more important, into the change process associated with teacher adoption of DDDM.

With regard to existing literature, the present study supported previous findings that teacher efficacy beliefs significantly influence impact-level concerns (i.e.,Charalambous & Philippou, 2010; Ghaith & Shaaban, 1999; McKinney et al., 1999; Newman et al., 1998) and that lower level concerns inform higher level concerns (Charalambous & Philippou, 2010; George et al., 2006). Most extant literature related to expounding on the relationship between concerns and efficacy used statistical methodology that only examined the mutual relationship between the variables. In this study, we used structural equation modeling to examine the unidirectional or causal influence of teacher DDDM efficacy on teacher DDDM concerns.

Of the existing research, only Charalambous and Philippou (2010) used similarly advanced statistical analyses to investigate this relationship. They found that teachers who were asked to use a new math curriculum and who held high-efficacy beliefs regarding teaching held lower impact concerns. The findings of the present study contradict Charalambous and Philippou's

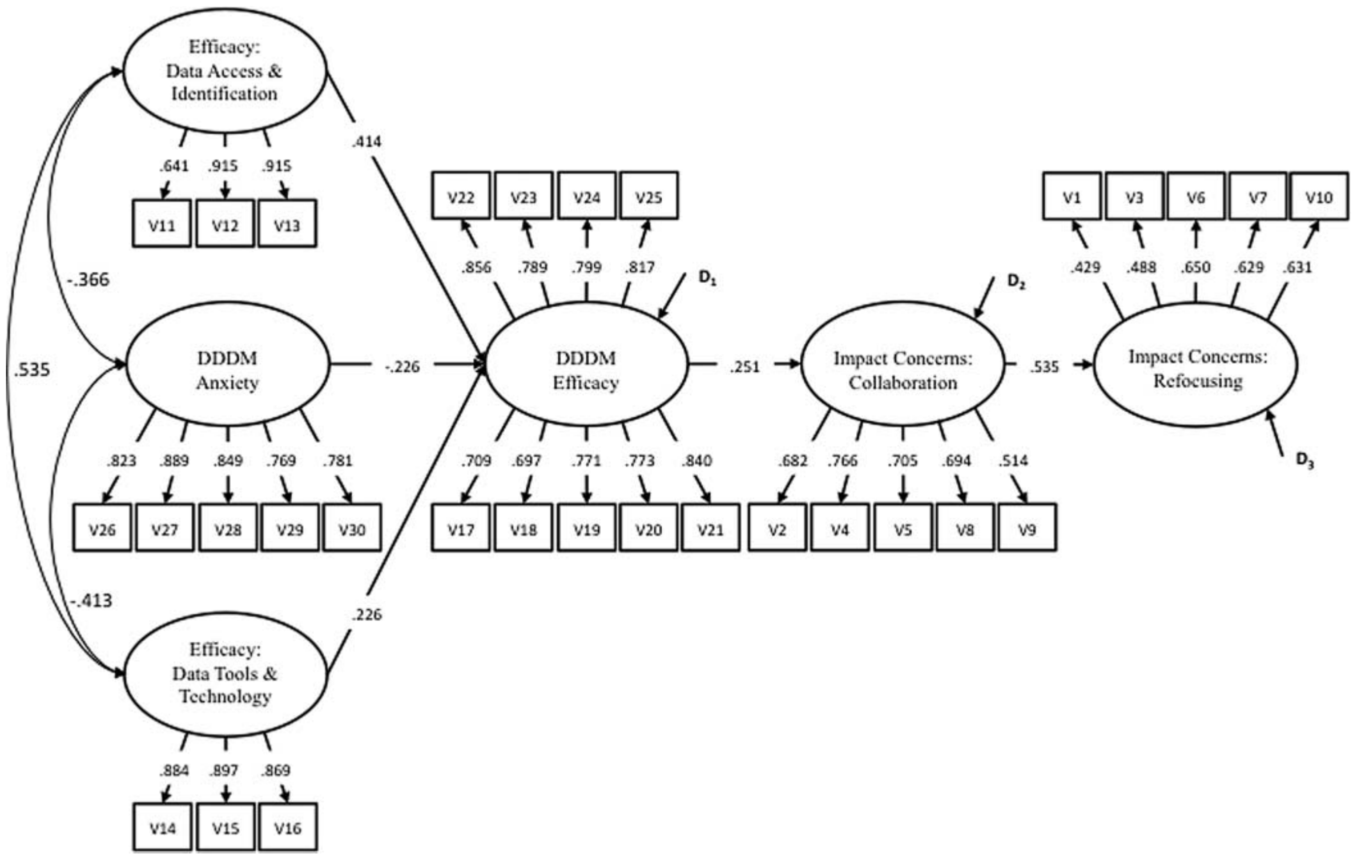

FIGURE 2 Structural model for linking Data-Driven Decision Making (DDDM) efficacy and DDDM concerns. Stages of Concern Questionnaire (SoCQ) items are V1–V10. 3D-ME items are V11–V30. DDDM = data-based decision making.

findings, indicating that teachers who held higher efficacy also held higher collaboration concerns (impact-level concerns). Thus, teachers in this study who were more confident in their ability to successfully engage in DDDM were more likely to be working with colleagues to improve and increase use of DDDM in their classrooms. The present findings aligned with the majority of previous research (e.g., Dunn et al, 2011; Dunn & Rakes, 2010; McKinney et al., 1999; Ghaith & Shaaban, 1999).

These differences may be the result of the different innovations studied, DDDM versus math curriculum. Differences may also have arisen from Charalambous and Philippou's (2010) use of a more general measure of teachers' sense of efficacy with the task-specific measure of concerns regarding implementation of the new math curriculum. In the present study, we studied efficacy and concerns at the task-specific level (i.e., DDDM) in accord with the recommendation that variables be measured at similar task levels in order to safeguard interpretation of statistical findings for accuracy (e.g., Bandura, 1997; Pajares, 1996). In addition, Charalambous and Philippou (2010) used a very small sample size for structural equation modeling, which requires larger sample sizes. Jackson (2003) recommended an ideal sample size-to-parameters ratio of 20 to 1 or a minimal acceptable ratio of 10 to 1. In the Charalambous and Philippou (2010) study, 35 items were used with a sample size of 151 teachers. In the present study, we used 30 items with a sample size of 550 teachers. Thus, the previous study may have revealed contradictory findings to the present study because of contextual issues or methodological issues.

In addition to working to clarify the discrepancy in the literature regarding the relationship between teachers' sense of efficacy and concerns, the present study added new insight to the understanding of the relationship between teacher efficacy and teacher concerns through the addition of task-specific anxiety to the model. The results of this study indicated that teachers' DDDM anxiety did significantly influence teachers' DDDM efficacy, which in turn influenced impact-level concerns. In particular, as teachers' DDDM anxiety decreased their DDDM efficacy increased as did their Collaboration and Refocusing Concerns. These findings indicated that it is important to address teachers' DDDM anxiety in order to facilitate teacher adoption of DDDM practices. No previous research regarding teacher efficacy and teacher concerns investigated the role of anxiety in the change process. This finding highlights the importance of understanding and addressing teacher anxiety regarding an innovation to support the change process within the context of DDDM reform.

Implications for Teacher Training

In addition, this study added new insight regarding the change process associated with teacher adoption of DDDM practices. Most professional development is focused on brief professional development seminars or workshops that focus on dissemination of knowledge, while neglecting the important role teacher beliefs play in the acquisition of new knowledge and the adoption of new innovations (Bruce et al., 2010). The present study's findings highlighted the importance of attending to teachers' sense of efficacy for DDDM, DDDM anxiety, and lower level DDDM concerns in order to help facilitate development of higher level concerns associated with engagement in an innovation. Research on professional development suggests that in order to address teachers' beliefs and concerns and achieve real teacher change schools must move beyond the one-shot seminar paradigm to on going job-embedded professional development (Bruce et al., 2010).

Bruce and her colleagues (2010) recommended delineating the terminology regarding teacher training in order to highlight the uniqueness of the two approaches. They defined professional development as traditional seminar training, and professional learning as "embedded in the classroom context and constructed through experience and practice in sustained iterative cycles of goal setting, planning, practicing, and reflecting" (p. 1599). This style of training allows for greater opportunity to address teacher efficacy and concerns. For example, Bruce and her colleagues (2010) found that professional learning resulted in significant increases in teachers' sense of efficacy for teaching as well as in increased student achievement. Similarly, Airola and Dunn (2011) found that by addressing teachers' DDDM efficacy and teachers' DDDM concerns through job embedded training resulted in increased teacher DDDM knowledge and engagement as well as student performance in mathematics.

In light of previous research regarding teacher training and present findings that teachers' sense of DDDM efficacy influences teachers' collaboration concerns, which subsequently inform higher level refocusing concerns, professional learning or job-embedded training may provide an optimal arena in which to address teachers' DDDM efficacy and DDDM concerns. Evidence supports that peer coaching is an effective means of increasing teacher efficacy (Bruce & Ross, 2008). Teacher peer coaching involves the pairing of two or more teachers who observe each other teaching, provide feedback regarding the observed teaching, and discuss how one may improve. Because many teachers have not yet acquired the foundational skills associated with effective DDDM (e.g., Volante & Fazio, 2007; Wayman, 2005), the identification of skilled DDDM teachers would be of paramount importance when creating peer coaching pairs or teams. If too few expert DDDM teaching coaches are available, it may be that training videos and guided discussion materials could be developed. Such virtual peer coaching videos could present step-by-step enactment of effective DDDM practices, common DDDM errors, and intermittent discussion breaks with guiding points to support meaningful interpretation of what was viewed.

Although increasing teacher DDDM efficacy will likely serve to decrease their DDDM anxiety, professional learning efforts should also focus on directly decreasing teachers' anxiety regarding DDDM. Although the literature regarding DDDM anxiety is new, a related area of research, statistics anxiety, may provide some insight on how to proceed. For example, research suggests statistics anxiety may be decreased through the use of real-world examples (Papanastaslou & Zembylas, 2008), humor (Wilson, 1998), and journaling about anxiety (Onwuegbuzie, DaRos, & Ryan, 1997). This study's findings, in conjunction with previous research, suggests that addressing efficacy and anxiety may improve teacher concerns and may result in greater teacher engagement in new innovations as well as improved student performance.

Limitations

In the present study, we focused on the analysis of data collected at one point in time. Therefore, the model only reflects the state of the relation of these variables at one point in the change process. This temporal limitation also did not allow for cross-validation of the model, and, while the sample size was sufficient for the present study, the sample was inadequate for a split-sample approach for cross-validation as recommended by Shah and Goldstein (2006). Also, this large sample was used to examine the validity of the model on K–12 teachers as a whole, but did not validate the model on unique subsets of this population (i.e., elementary, secondary, math education, literacy education).

With regard to the final limitation, it is important to note the obstacles that prevented the validation of the present model on various levels of teachers. If the researchers had been allowed to collect demographic data that allowed for teacher–student matching, teacher–grade-level matching, or teacher–subject matter matching, this problem would clearly have been avoided. However, when working with states, districts, or individual schools, researchers must adhere to and respect the restrictions and policies of those educational entities. A secondary obstacle to delineating teacher level in this study was the design of the varied configuration of the professional learning communities.

On the basis of our experience with the statewide professional development efforts assessed in the present study, we hypothesized that teachers' DDDM efficacy and concerns would differ to some degree as a result of grade level and subject area assignment for the following reasons. Elementary settings tend to support collaborative DDDM opportunities through a variety of activities such as grade-level team meetings, professional learning communities, and data team meetings. High school structures and schedules tend to present more barriers to teacher collaboration. The scheduling and the flexibility that is inherent in the elementary and middle school structures tend to facilitate team discussion opportunities. By comparison, junior and senior high school scheduling and structures tend to obstruct opportunities for teacher DDDM collaboration. Further, teacher characteristics associated with grade level and subject matter may also affect DDDM efficacy and concerns differentially. For example, when compared with elementary school teachers, secondary math and science teachers may be more comfortable and familiar with the concepts and work involved in DDDM, resulting in greater DDDM efficacy. By better understanding the obstacles faced in this study and the present hypothesis, future researchers may better answer the question of whether or not this model varies among the different levels of teaching and subject matter.

Future Research

Future studies are needed to cross-validate this model with regard to DDDM reform efforts across varying contexts. The present study examined teachers from elementary to high school settings in a northwestern state. Thus, the model should be validated on teachers from succinct levels of education because elementary, middle school, and high school teachers use different data sources and face unique challenges to incorporating DDDM in their teaching practice. Moreover, each state has unique policies, tests, and data systems that may result in changes in the model. As a result of variations among states, the model should be validated on teachers in other states.

Future research should also explore the stability of this model across different reform contexts. For example, the findings of this study contradict those of Charalambous and Philippou (2010) with regard to teacher adoption of math curriculum reform. Although Charalambous and Philippou's (2010) findings were limited by a small sample size, it could be that differences exist in the present model across different reform contexts. Future research efforts should explore whether this model is stable or how this model may change as teachers' experience more training. Research should also investigate if this model remains stable across the two different forms of teacher training discussed, professional development and professional learning. Future research should explore the effect of training designed to address these components related to teacher adoption of DDDM on teacher engagement in DDDM. As anxiety has not been incorporated in other research on the relationship between efficacy and concerns, it will also be important to further explore the synergistic influence of these variables on teacher adoption of DDDM practices and other reform related innovations.

Conclusion

Although more research is needed, this study is an important early step in the exploration of teachers in the change process associated with the adoption of DDDM. Because teacher engagement in DDDM has shown to have a powerful positive influence on student outcomes (Armstrong & Anthes, 2001; Schuerich & Skrla, 2003; Airola & Dunn, 2011), it is important to better understand how to help teachers become data driven decision makers. It is unfortunate that research on teacher adoption of DDDM remains sparse. As schools and districts continue to spend large sums on teacher training aimed at helping teachers become effective data-driven decision makers, it is critical that educational researchers engage in further research to better understand how to help schools meet this goal. This study brought useful, initial insights to the onset of this field of research; however, far more research is needed to better understand the role of these and other variables that may contribute to more DDDM at the classroom level.

AUTHOR NOTES

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