Investigating Teacher's Practices and Beliefs of Data Literacy to Enhance Pre-service Teacher Education

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This study assesses K-12 teachers' beliefs, contextual supports, and actual uses of student data. Results showed that teachers' beliefs, school environments, and engagement in substantive data-driven analyses are associated with their use of periodic and classroom-based data to inform their instruction and communications with instructional coaches, students and their parents. Explicated in this paper are specific recommendations for substantive changes in pre-service and in-service teacher training. Both are of great relevancy in providing teacher training that truly cultivates educators' data literacy, and their capacity to expand opportunity for all students through data-driven practice.

Investigating Teacher's Practices and Beliefs of Data Literacy to Enhance Pre-service Teacher Education

Pre-service teachers' knowledge of assessment and data literacy is of great importance, in part, due to the heightened focus on data driven decision-making and accountability in P-12 schools (DeLuch et al., 2010; Mandinach & Gummer, 2016; Popham, 2011; vanGeel, M. et al., 2017). Substantiating this are current accreditation standards, requiring educator preparation programs to assess their pre-service teachers developing skills, throughout their training, within the realm of data literacy (National Council for the Accreditation of Teacher Education [NCATE] 2008; Council for the Accreditation of Educator Preparation [CAEP 2013]; Interstate Teacher and Assessment Support Consortium [InTASC], 2013).

Despite its importance, results indicate that it is challenging for pre-service teachers to cultivate skills in data literacy. For example, the authors' assessed the degree to which a cohort of student teachers, at the close of their internship, believed they were proficient in: "assessment, meeting the diverse needs of learners, learner engagement, learning environment, literacy, professional learning and ethical practice," and "technology." Overall, respondents consistently cited "assessment" as an area of relative weakness. This was of concern, as teachers' data literacy skills equip them to make empirically-sound determinations regarding whom to recommend for AP classes, as well as which K-12 learners need targeted support. These tasks of teaching are prerequisites for advancing students' success and educational equity for all learners.

To address this problem, the authors' endeavored to more clearly understand what

pre-service teachers need to know about assessment upon assuming their roles as practitioners. Thus, the purpose of this study was to determine how practicing teachers use data to support instruction, their attitudes toward data, and the supports that help them use data, to inform the curricular and pedagogical revisions to teacher training in assessment.

Theoretical framework

The concept of assessment literacy in education has evolved over time. In years past, coursework and textbooks used in teacher education programs emphasized concepts within testing and measurement, such as validity and reliability, as they pertained to summative assessments and evaluation (Coombs et al., 2018; Mandinach & Gummer, 2016). It was assumed that if students knew these concepts, then they had the requisite assessment literacy skills. According to Popham (2018), assessment literacy "consists of an individual's understanding of the fundamental assessment concepts and procedures deemed likely to influence educational decisions" (p. 2).

It became clear, however, that knowing which data teachers should use to make decisions is not limited to summative student outcomes; instead, it includes formative assessments, interest inventories, performance assessments, and attendance data, to name a few. This shift emphasizes the importance of a teacher's ability to triangulate multiple sources of data and use them to make pedagogical decisions about what and how to teach next (Coombs et al., 2018; Mandinach & Gummer, 2016; Remesal, 2011). The use of multiple forms of data is indicative of a shift from the concept of (more circumscribed) assessment literacy to data literacy, of which the latter is quite complex. Specifically, Mandinach and Gummer (2015) indicate that teachers' data literacy is a function of their "understanding of data with standards, disciplinary knowledge and practices, curricular knowledge, pedagogical content knowledge, and an understanding of how children learn/develop" (p. 2).

Further study of classroom assessment has linked assessment practices to teacher beliefs and socio-cultural and institutional influences (Combs et al., 2018; Pastore & Andrade, 2019; Remesal, 2011; Xu & Brown, 2016). Researchers posit that a teacher's views of assessment and the degree to which they use data to make pedagogical decisions are influenced by personal beliefs, school culture, and discipline and pedagogical knowledge (Remesal, 2011; Xu & Brown, 2018. For example, Hoogland et al. (2016) found that collaboration among teachers and their attitudes toward data use, as well as contextual variables such as the degree to which they are supported by school administrators, were all factors in a teacher's use of data to make decisions.

Because of the evolving nature of assessment/data literacy, researchers have called for a new framework for assessment literacy education that moves beyond training in the assessment knowledge base, but also considers school-based factors such as teacher beliefs and the larger school/community culture (Combs et al., 2018; Xu & Brown, 2018;). In this paper, we employ this evolving and complex view of assessment/data-based decision making to examine practicing teacher's data use, beliefs, and perceived supports to inform curriculum development in a pre-service teacher education program.

Methods

Participants

In this study, participants included 182 in-service teachers working in a variety

of K-12 schools within the southeastern United States. As is evident in Table 1 (below), the majority of respondents who reported their place of employment and years of experience had taught for 15 or more years, were working in Title I schools, and/or worked at K-12 institutions within rural areas.

Table 1

Characteristics of Study Sample

Total Sample = 182 in-service teachers		
	Values	Percentage
Grades P-2	55 participants	32.5%
Grades 3-5	70 participants	41.4%
Grades 6-8	23 participants	13.6%
Grades 9-12	21 participants	12.4%
Did not report	13 participants	
Urban	10 participants	7.9%
Suburban	51 participants	40.4%
Rural	65 participants	51.5%
Did not report	56 participants	
25% Eligible for FRL	11 participants	14.1%
50% Eligible for FRL	18 participants	23%
75% Eligible for FRL	49 participants	62.8%
Did not report	104 participants	
Taught 1-5 years	29 participants	
Taught 6-9	21 participants	
Taught 10-14 years	32 participants	
Taught 15+ years	99 participants	
Did not report	1 participant	

**FRL refers to Free and Reduced Lunch.*

Percentages do not sum to 100% due to rounding error.

Data Collection and Data Sources

Both teachers and administrators were asked to participate by email; the message and a link to the survey (in Qualtrics) was sent to them by the University's school partnership liaison who worked at the same college as the authors. Potential participants were told that the Data Use Survey can provide teacher educators with information regarding how in-service teachers use data, their beliefs about data and its utility in practice, and the degree to which they have access to contextual supports for data use.

An assessment of the psychometric properties of the Data Use Survey (internal consistency, test-retest reliability, correlated subscales, and convergent validity) indicate they are of sufficient quality (Wayman et al., 2016).

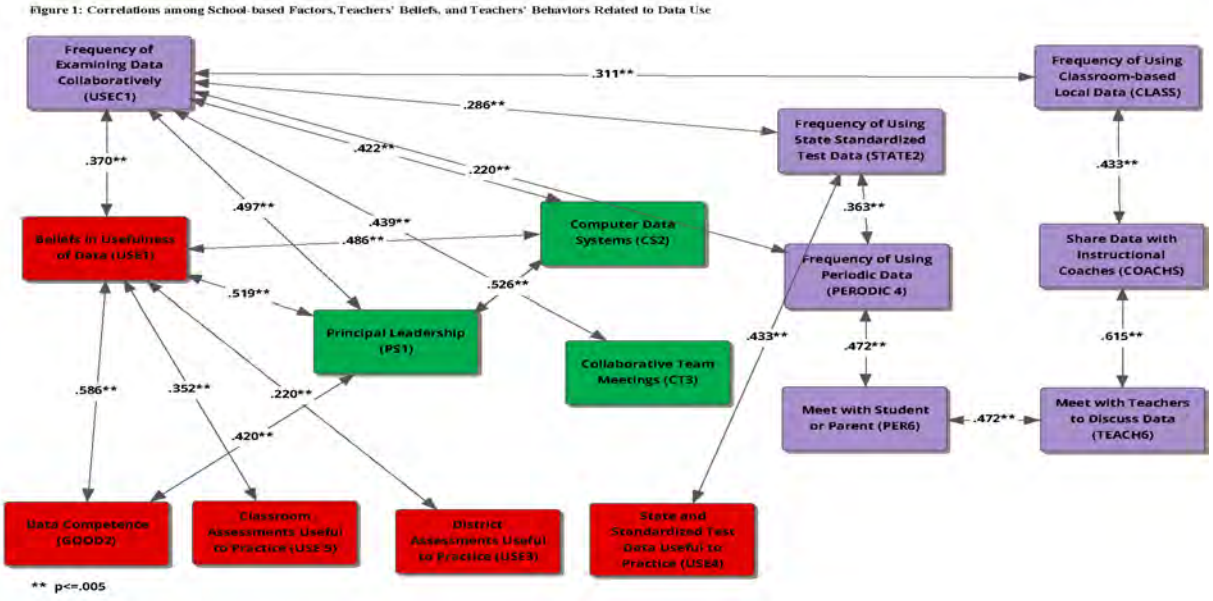
Data Analyses

A principal components analysis (PCA) was run on all of the strongly intercorrelated items within the scale themes reported by Wayman et al., (2016) in the Data Use Survey. Once the data were reduced through PCA into interpretable constructs, responses to the survey questions were averaged to create component-based scores. The associations among those components were then correlated, to explore how variance in the contextual features within teachers' school contexts is related to their beliefs about data use and their corresponding behaviors.

were a) school-based factors: levels of principal support, the quality/functionality of school-based computer systems and group norms associated with teacher collaboration; b) teachers' beliefs: in-service teachers' attitudes towards data use/perceived ability to use data; and, c) teachers' behaviors: in-service teachers actual data use. Technical details regarding the PCA protocol and factor interpretability are explicated in Appendix A.

Spearman's correlations were used to assess the strength and direction of the relationships among components. Strong, positive, statistically significant associations are diagrammed below.

Figure 1: Correlations among School-based Factors, Teachers' Beliefs, and Teachers' Behaviors Related to Data Use



Results

Several important results emerged from these data regarding the constructs assessed by the Data Use Survey and the interactions among them. Principal component scores, which are enumerated in Appendix B, were related to three, broad areas assessed by the Data Use Survey. They

For ease of interpretation, components related to school-based support are denoted by green text, components related to teacher beliefs are denoted by red text, and components related to teachers' actual use of data are denoted by purple text. Results indicate that as the availability of

supports increases, including the provision of user-friendly computer databases, principal encouragement/expertise, and the establishment of social norms fostering trust and respect among teachers in collaborative groups, the frequency of teachers engaging in data-driven collaborative analyses increases. Per the items within the measure used in this study, data-driven collaborative analyses are defined as teachers working together to address issues through the use of data, as well as formulate questions, examine patterns and trends, and identify actionable solutions. Thus, norms, processes and practices within schools are variables that serve to either attenuate or cultivate data driven teacher collaboration. In addition, the more teachers feel supported the more likely they are to believe data are useful in informing practice and the more confidence they have in their ability to use data to diagnose the needs of students.

Teachers who engage in these collaborative, data-driven analyses are also more likely to use periodic and classroom-based local data to inform both their instruction, and their meetings with instructional coaches, other teachers, students and their parents. They are also more likely to use state standardized test data. Thus, not surprisingly, data use is associated with teachers' collaborative data analyses, which increase in schools where the contextual factors facilitate these practices. In addition, engagement in collaborative, fruitful analysis of student data to solve problems and make instructional decisions is not strongly related to teachers' beliefs in the utility of standardized test outcomes, rather it is a function of their engagement in data use (which again, is fostered or hindered by the contexts in which they work).

Significance

This research aimed to examine practicing teacher's data use, beliefs, and perceived supports. Figure 1 substantiates the findings of Coombs et al. (2018) and Xu (2016) that teachers' data use is influenced by personal, social, and contextual aspects of teaching and is more than isolated assessment knowledge and skills. These results suggest that the degree to which teachers are data literate is not an isolated aspect of teacher effectiveness to be added to a list of other professional competencies but rather it is an integral facet of them. Teacher behaviors associated with effective teaching, such as working together to address issues through the use of data, formulating questions, examining patterns and trends, identifying actionable solutions, considering changes in practice, and examining preconceived beliefs cannot be performed by teachers who are not data literate. Instead, as illustrated in Figure 1, they are associated with specific types of data use.

This impacts how teacher education programs teach pre-service teachers to be assessment/data literate. We concur with Xu (2016) that "teacher assessment literacy development is not merely an accumulation of assessment knowledge, but rather the development of a sophisticated, contextually-appropriate set of inter-related competencies" (p. 155). In order to learn these complex skills, anchored in specific contexts, didactic instruction of isolated assessment concepts is not sufficient. We must instead actively engage pre-service teachers in the behaviors we wish to inculcate – collaborating in data analysis, examining patterns and trends in data, and identifying actionable solutions including changes in practice, and examining preconceived beliefs.

First and foremost, pre-service teachers have to learn about assessment through hands-on experiences. These skills are rooted in action. We agree with Coombs et al. (2018) that learning opportunities that allow for

collaborative inquiries in assessment are imperative. Pre-service teachers cannot learn assessment in a manner that is estranged from community and context. Learning these complex skills will take scaffolding and complex social interaction in which pre-service teachers engage in authentic scenario-based learning. Having authentic conversations about data, scaffolded by a "more seasoned other" (Vygotsky, 1978), will provide pre-service teachers a low-stakes environment in which to actively engage in the behaviors associated with effective teaching. Provide scenario based, authentic case studies using real-world p-12 student data. Pre-service teachers need practice analyzing actual student work in order diagnose student strengths and weaknesses, and determine the next steps in the teaching process. Pre-service teachers should practice analyzing assessment data and determining next steps in collaborative teams rather than in isolation. Data analysis is a complex process that is strengthened when teachers are allowed to work together to analyze student work and discuss next steps.

Placement data literacy content is also important. Examining patterns in data and determining appropriate teaching strategies requires pre-requisite content and pedagogical knowledge. Pre-service teachers must have a firm grasp on the content they are teaching before they can diagnose content misunderstandings. Additionally, they must learn evidence-based instructional practices before they can modify those practices to meet the needs of their students. Without this, they will continue to rely on "hunches" regarding what their students know and are able to do; these intuitive assumptions can be colored by biases that serve to reinforce inequities in the US educational system. Assessment should be a strand throughout the teacher preparation curriculum rather than limited to an isolated course. Pre-service teachers need many opportunities, spread out over time, to review data, analyze common misunderstandings, and plan next instructional steps. Gaining data literacy knowledge, pedagogical knowledge, and content knowledge is developmental. Large gains can be made by building in structured, authentic experiences over time. Methods courses should contain data literacy components so that pre-service teachers learn specific teaching strategies associated with clarifying p-12 student misunderstandings indicated on formative assessments. These methods classes can only come after pre-service teachers have a firm grasp on the content they will be teaching. It is difficult to diagnose misunderstandings without a firm grasp on the content being taught. Making sound instructional decisions based on data involves data literacy knowledge, pedagogical knowledge, and content knowledge.

Limitations

It is unclear if these findings are generalizable to teachers working in other geographic regions of the United States, or in urban areas. The percentage of respondents who teach on the secondary level was lower, relative to those teaching PK-5th grades, thus the external validity of these results to that population is unclear. Additional studies with larger sample sizes and representation across the country are warranted, given the relevancy of the results described.

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Appendix A

Principal Support, School-Based Computer Systems, and Teacher Collaboration

A principal components analysis (PCA) was run on 16 items within the Data Use Survey that measured teachers' access to computer-based student data, principal support and collaboration for 182 respondents. The suitability of PCA was assessed before commencing the analysis. Specifically, all variables in the correlation matrix had at least one correlation coefficient greater than 0.3, the Kaiser-Meyer-Olkin (KMO) measure was 0.889, and Bartlett's Test of Sphericity was statistically significant ($p < .0005$), indicating the data were likely factorizable.

PCA revealed three components that had eigenvalues greater than one and which explained 46.09%, 63.59%, 75.77% of the total variance, respectively. Visual inspection of the scree plot indicated that the three components should be retained. A Varimax orthogonal rotation was executed to facilitate interpretability. The rotated solution exhibited a structure that was consistent with the contextual factors the questionnaire was designed to measure. Specifically, principal and assistant principal support were strongly loaded on Component 1, the quality of school-based computer systems – and the student data generated therein – were loaded on Component 2, and items pertaining to teacher collaboration/trust were loaded on Component 3.

In-service Teachers' Attitudes Towards Data

A principal components analysis (PCA) was run on 17 items within the Data Use Survey that measured teachers' perceived skills in using data and beliefs regarding its utility for their professional practice for 182 respondents. All variables in the correlation matrix had at least one correlation coefficient greater than 0.3, the Kaiser-Meyer-Olkin (KMO) measure was 0.907, and Bartlett's Test of Sphericity was statistically significant ($p < .0005$), indicating the data were likely factorizable.

PCA revealed five components that had eigenvalues greater than one and which explained 43.17%, 62.56%, 71.14%, 78.69%, and 85.36% of the total variance, respectively. Visual inspection of the scree plot indicated that the five components should be retained. A Varimax orthogonal rotation was executed to facilitate interpretability. The rotated solution exhibited a structure that was consistent with the contextual factors the questionnaire was designed to measure with strong loadings of teachers' beliefs regarding the utility of data use in effective practice on Component 1 (including teachers' beliefs in the utility of classroom-based data). Teachers beliefs regarding how well they use data was loaded on Component 2; teacher beliefs in the usefulness of district level assessments was loaded on Component 3; teacher beliefs regarding the usefulness of state level assessments was on loaded on Component 4; and teachers beliefs regarding the usefulness of periodic assessments was loaded on Component 5.

Data Use

A third principal components analysis (PCA) was run on 34 items within the survey that measured teachers' engagement in data use. The correlation matrix showed that all variables had at least one correlation coefficient greater than 0.3. The overall Kaiser-Meyer-Olkin measure was 0.726; Bartlett's Test of Sphericity was statistically significant ($p < .0005$), indicating the data are factorizable.

PCA revealed seven components that had eigenvalues greater than one and which

explained 31.51%, 44.27%, 56.37%, 66.65%, 72.51%, 75.97%, and 79.14 of the total variance, respectively. Visual inspection of the screen plot indicated seven components should be retained. A Varimax orthogonal rotation indicated that the data are consistent with the teacher beliefs' factors the measure was designed to assess with strong loadings of teachers' work in collaborative teams on Component 1. Use of state exam data to inform targeted instruction/communicate with students and their parents was loaded on Component 2; teachers' use of classroom-based assessments to tailor instruction/communicate with parents loaded on Component 3; and, teacher use of periodic data to tailor instruction was loaded on Component 4. In addition, meeting with an instructional coach to discuss periodic or classroom based data was loaded on Component 5; meeting with a parent or teacher to discuss periodic data was loaded on Component 6; and meeting with another teacher to discuss periodic data with a teacher was loaded on Component 7.

Appendix B

Principal Support, School-Based Computer Systems, and Teacher Collaboration/Group Norms

Component 1 (PS1)
Indicate the degree to which you agree or disagree:
My principal discusses data with me.
My principal made sure teachers had plenty of training for data use. My principal is a good example of an effective data user. My principal creates many opportunities for teachers to use data. My principal creates protected time for using data. My principal encourages data use as a tool to support effective teaching.

Component 2 (CS2)
Indicate the degree to which you agree or disagree:
School based computer systems provide me with access to lots of data. Computer systems for data use are easy to use. Computer systems in district allow me to examine multiple types of student data at one time (attend, achieve, demographics). Computer systems in the district generate displays that are useful to me (tables graphs reports).

Component 3 (CT3)
Indicate the degree to which you agree or disagree (pertaining to collaborative teams):
Members of my team respect colleagues who lead school improvement efforts.
It's okay to discuss feelings and worries with other members of my team.
Members of my team trust each other.
Members of my team respect those colleagues who are experts in their craft.
My principal or assistant principal(s) fosters a trusting environment for discussing data in teams.

In-service Teachers' Attitudes Towards Data

Component 1(USE1)
Indicate the degree to which you agree or disagree:
Using data helps me to be a better teacher.
Students benefit when teacher instruction is informed by data. I find data useful.
I think it is important to use data to inform education practice. I like to use data.
Data help teachers identify learning goals for students. Data help teachers know what concepts students are learning. Data offer information about students that was not already known. Data help teachers plan instruction. How useful are personal data or classroom based assessments such as quizzes, homework, portfolios, end of unit

tests and/or writing assignments, etc., to your practice?

Component 2(GOOD2)
Indicate the degree to which you agree or disagree:
I am good at using data to set student-learning goals. I am good at adjusting instruction based on data. I am good at using data to plan lessons. I am good at using data to diagnose student-learning needs.

Component 3 (USE3)
To what extent are district-level assessments (common formative and/or summative assessments) useful to your practice?

Component 4 (USE4)
To what extent are SC State Tests including SCPASS, SC READY, EOC's useful to your practice?

Component 5 (USE5)
To what extent are MAP Scores, Running Records, DIBELS useful to your practice?

Data Use

Component 1(USEC1)
How often do you and your collaborative team(s) do the following? We use data to make links between instruction and student outcomes. We identify additional data to offer a clearer picture of the issue. We identify actionable solutions based on our conclusions. When we consider changes in practice, we predict possible student outcomes. We draw conclusions based on data. We approach an issue by looking at data. We identify questions that we will seek to answer using data. We explore data by looking at patterns and trends. We revisit predictions made in previous meetings. We discuss our preconceived beliefs about an issue.

Component 2(STATE2)
In a typical school year, how often Use SC State Exam Data to? Tailor instruction to individual student's needs. Develop recommendations for additional instructional support. Form small groups of students for targeted instruction. Meet with another teacher about South Carolina State Exam Data. Identify instructional content to use in class. Discuss SC State Exam Data with a student. Discuss SC State Exam Data with a parent or guardian. Meet with a specialist (e.g., instructional coach or data coach).

Component 3(CLASS3)
Classroom Based Assessments (such as quizzes, homework, portfolios, end of unit tests and/or writing assignments)…In a typical school month, how often do you use local data to? Identify instruct content for class. Develop recommendations for additional instructional support. Use local data/ to tailor instruction to meet individual student needs. Use local data/to form small groups of students for targeted instruction. Discuss local data/with a student. Discuss local data/with a parent.

Component 4(PERIODIC4)
Periodic data collected such as MAP scores, running records…In a typical school month, how often do you? Use periodic data to tailor instruction. Use periodic data to develop recommendations for additional instruct support. Use periodic data to identify instructional content for class. Use periodic data to form small groups.

Component 5(COACH5)
Classroom Based Assessments…In a typical school month, how often do you meet with a specialist (e.g., instructional coach)? Periodic data…In a typical school month, how often do you, meet with a specialist (e.g., instructional coach)?

Component 6 (PER6)
Periodic data collected such as MAP scores, running records, In a typical school month, how often do you: Discuss periodic data with a parent. Discuss periodic data with a student.

Component 7(TEACH6)
Periodic data collected MAP scores, running records…In a typical school month, how often do you meet with another teacher about periodic data.
Classroom Based Assessments…In a typical school month, how often do you meet with another teacher about local data.