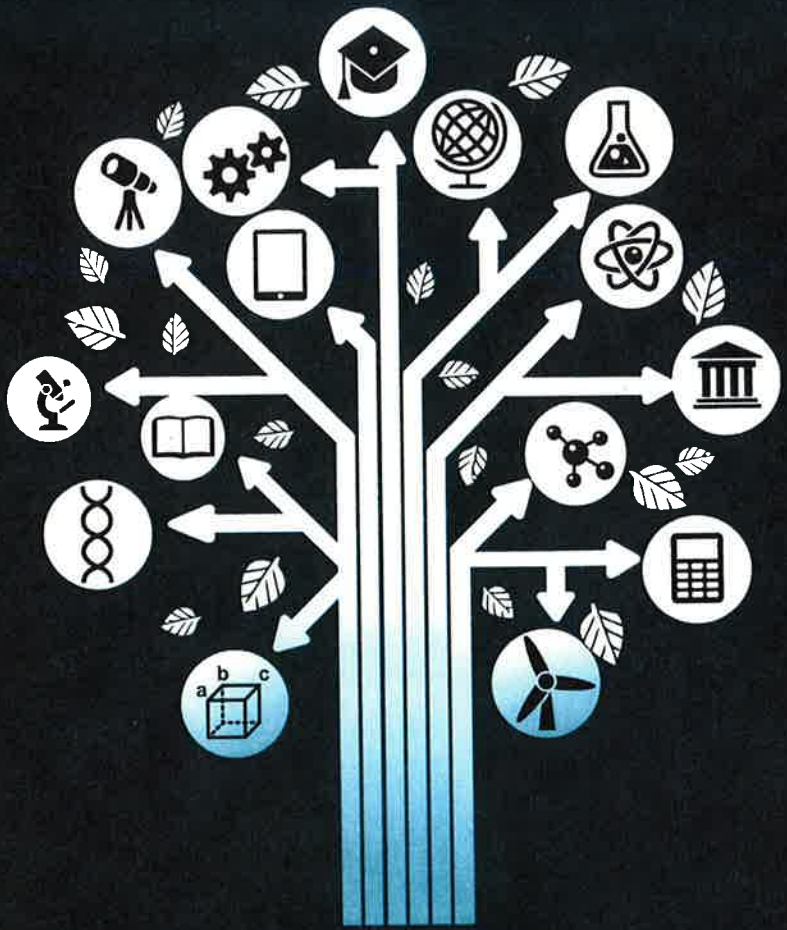
Transforming Institutions

Undergraduate STEM Education for the 21st Century



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Amy L. Childress, and Linda Slakey

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Describing Instructional Practice and Climate: Two New Instruments

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IDENTIFICATION OF CHALLENGE

Most faculty have knowledge of evidence-based instructional practices and access to the resources to carry them out. Despite this, efforts to transform postsecondary instruction have met with only modest success (e.g., American Association for the Advancement of Science [AAAS], 2013). Institutional environments and structures may be one of the underlying barriers to changing instruction (Beach, Henderson, & Finkelstein, 2012; Henderson, Beach, & Finkelstein, 2011). One measure of an institutional environment is climate. Climate is a more immediately accessible and malleable construct than organizational culture, as it can be changed through policy or other administrative and organization-member actions. As such, climate is a productive conceptual frame to apply in research that attempts to inform policy and practice change initiatives (Schneider, Ehrhart, & Macey, 2013).

However, in order to measure the impact of change initiatives, it is paramount to have reliable and valid methods to measure climate and instructional practice (AAAS, 2013). The goal of this research study was to design and validate instruments that elicit (a) organizational climate for instructional improvement and (b) postsecondary instructional practices. The resulting surveys, SCII and PIPS, are reliable, interdisciplinary, and can collect data quickly from a large number of participants. In this paper, we share these research tools, explain our development and data collection processes, highlight preliminary results, and provide suggestions for use of the instruments.

RESEARCH STUDY

As part of a larger project on postsecondary instructional change, we have developed two instruments to elicit climate and instructional practices in higher education settings. In this section, we describe background literature,

conceptual frameworks, item development, scales, and validation of our surveys. We follow with a discussion of preliminary results and implications. The results we present in this chapter represent our thinking as of the *21st Century Transforming Institutions* conference in October 2014. We encourage interested individuals to contact our research team for the most relevant publications associated with this project.

Research Tool 1—Survey of Climate for Instructional Improvement (SCII)

Background

Climate can be described as either an individual (psychological) construct or as a property of an organization (Kozlowski & Klein, 2000) when individual perceptions are aggregated to the group level and consensus can be demonstrated (Dansereau & Alluto, 1990; James, Demaree & Wolf, 1993; James & Jones, 1974; Kozlowski & Hults, 1987). Since our research project focused on the influence of climate on postsecondary instructional practices, we chose to explore the institutional environment through the lens of organizational climate. This choice limits potentially idiosyncratic data and explores different questions than the work relating teaching practices and self-efficacy (e.g., Tschannen-Moran & Johnson, 2011).

Organizational climate is defined as the shared perceptions of organization members about elements of the organization. These elements influence individual attitudes and behaviors and include patterns of relationships, atmosphere, and organizational structures (Peterson & Spencer, 1990; Schneider, 1975, Schneider & Reichers, 1983; Schneider et al., 2013). Climate can operate on many different organizational levels (Kozlowski & Klein, 2000) and therefore is most useful when focused on a specific outcome—i.e., climate *for* something (Schneider, 1975). In our case, we were interested in *climate for instructional improvement*, which we define as the action or process of making changes in teaching with the goal of achieving the best possible learning outcomes. This change-making process includes the introduction or continued use of evidence-based instructional strategies, technologies, and/or curriculum.

Conceptual framework

We first examined the literature for theoretical and conceptual frameworks from which to develop the climate survey. The framework of faculty work elements identified by Gappa, Austin, and Trice (2007) was eventually chosen for its alignment with the aspects of climate that we were interested in. This framework consists of three aspects of faculty work experience (academic freedom

and autonomy, collegiality, professional growth) and three characteristics of academic organizations (resources, rewards, leadership). An important strength of this framework for our purposes was that it aligned with related literature on workplace "climate for change" (Bouckenooghe, Devos, & Van den Broeck, 2009), the nature of academic work and workplaces (Massy, Wilger, & Colbeck, 1994), departmental teaching climate (Beach, 2002; Knorek, 2012), and leadership for teaching (Ramsden, Prosser, Trigwell, & Martin, 2007).

We identified seven components of climate for instructional improvement that could potentially be measured through survey by combining the Gappa et al. framework with related literature (Table 1). These seven components include: resources (Beach, 2002; Gappa et al., 2007, Knorek, 2012), rewards (Beach, 2002; Gappa et al., 2007; Knorek, 2012), professional development (Beach, 2002; Gappa et al., 2007), leadership (Beach, 2002; Bouckenooghe et al., 2009; Gappa et al., 2007; Ramsden et al., 2007), collegiality (Beach, 2002; Gappa et al., 2007; Massy et al., 1994), academic freedom and autonomy (Gappa et al., 2007), and general attitudes about students and teaching (Beach, 2002; Ramsden et al., 2007).

Item development

Items for the SCII were developed based on existing surveys when possible (Bouckenooghe et al., 2009; Hurtado, Eagan, Pryor, Whang, & Tran, 2011; Knorek, 2012; Ramsden et al., 2007) and self-generated when necessary. We sought to refer to group, rather than individual, perceptions as items were generated and revised, so that organization-level perceptions were properly represented (Glick, 1985). This approach involved changing the referent of existing items from the individual to the organizational level (e.g., "the instructors in my department think" rather than "I think"). We also revised existing items to refer to "instructors" instead of "faculty" and changed terms like "tenure" to "continued employment" since full-time, part-time, graduate student instructors were surveyed.

Scale

We purposefully chose a six-point Likert style scale for SCII that uses the following response options: strongly agree, agree, somewhat agree, somewhat disagree, disagree and strongly disagree. Six-point agree-disagree scales are considered preferable to 4-point scales, as they generate better variance (Bass, Cascio, & O'Connor, 1974). There is no neutral point on the scale, as forcing agreement or disagreement avoids an increase in participants claiming "no opinion" when they actually have one (Bishop, 1987; Johns, 2005).

TABLE 1. Operational Definitions and Sources of Organizational Climate Components Used to Develop Items on the SCII.

Component	Definition	Concept Source	Definition Source
Rewards	Recognition of teaching excellence through awards or job security measures.	Beach, 2002 Knorek, 2012	Self-generated
Resources	Tools necessary for instructional improvement, including funding, office space, equipment, and support services.	Gappa et al., 2007 Beach, 2002	Gappa et al., 2007 (modified)
Professional Development	Opportunities that enable instructors to broaden their knowledge, abilities, and skills to address challenges, concerns, and needs, and to find deeper satisfaction in their work.	Gappa et al., 2007 Beach, 2002 Knorek, 2012	Gappa et al., 2007, p. 280
Collegiality	Opportunities for instructors to feel they belong to a mutually respectful community of colleagues who value their contributions, and to feel concern for their colleagues' well-being.	Massy et al., 1994 Gappa et al., 2007 Bouckenooghe et al., 2009	Gappa et al., 2007, p. 305
Academic Freedom and Autonomy	Right of all instructors to teach without undue institutional interference, including freedom in course content and instructional practices.	Gappa et al., 2007	Gappa et al., 2007, p. 140–141 (modified)
Leadership	Policies, actions, or expectations established by the formal leader of the department that communicate the value of teaching and instructional improvement.	Beach, 2002 Bouckenooghe et al., 2009	Self-generated
Shared perceptions about Students and Teaching	Shared perceptions of the individuals in a department regarding student characteristics and instructional practices that may influence improvements in teaching.	Beach, 2002 Ramsden et al., 2007 Hurtado et al., 2011	Self-generated

Research Tool 2—Postsecondary Instructional Practices Survey (PIPS)

Background

There are multiple ways to measure the teaching practices of postsecondary instructors, including self-report surveys and observational protocols. We see surveys as a preferable method, since observational protocols (e.g., RTOP, Piburn, Sawada, Falconer, Turley, Benford, & Bloom, 2000; TDOP, Hora, Oleson, & Ferrare, 2012) require training and expertise, are expensive and difficult to implement at scale, and risk reliability issues.

Although 10 surveys of instructional practices were summarized in a recent AAAS report (AAAS, 2013), none were designed to elicit teaching practices (and only teaching practices) from an interdisciplinary group of postsecondary instructors. Most existing instruments are designed for use in a particular discipline: physics and engineering (Borrego, Cutler, Prince, Henderson, & Froyd, 2013; Brawner, Felder, Allen, & Brent, 2002; Dancy & Henderson, 2010), chemistry and biology (Marbach-Ad Schaefer-Zimmer, Orgler, Benson, & Thompson, 2012), geosciences (MacDonald, Manduca, Mogk, & Tewksbury, 2005), or statistics (Zieffler, Park, Garfield, delMas, & Bjornsdottir, 2012). Other instruments elicit teaching beliefs or goals for student learning, and not actual teaching practice (e.g., ATI; Trigwell & Prosser, 2004). The remaining surveys are interdisciplinary and elicit teaching practices, but elicit a very wide range of faculty practices beyond teaching. These include the FSSE (Center for Postsecondary Research, 2012), HERI (Hurtado, Eagan, Pryor, Whang, & Tran, 2011), and NSOPF (National Center for Educational Statistics, 2004). Two of these are only available on a proprietary basis (NSOPF, HERI).

Seeking an interdisciplinary, non-proprietary, and succinct survey of postsecondary instructional practices, we designed a new instrument. The resulting survey, PIPS, is designed to be easy-to-use, non-evaluative, and collect data quickly from a large number of participants.

Conceptual framework

In absence of an appropriate instrument, we turned to the empirical and theoretical literature about evidence-based teaching practices. There is no conceptual model of instructional practice despite excellent literature reviews describing research on instructional practices (e.g., Pascarella & Terenzini, 1991; 2005). Without a model from which to develop instructional practice items, we shaped the dimensions of our instrument by finding themes among (a) developed instruments, (b) teaching observation protocols and (c) patterns in research on instructional practice. We compiled 153 items by combining all available

questions and literature patterns from two published instruments (FSSE, ATI), two observational protocols (RTOP, TDOP), and comprehensive literature reviews (Iverson, 2011; Meltzer & Thornton, 2012; Pascarella & Terenzini, 1991; 2005).

From an initial set of 153 questions, we reduced the number of questions by removing redundant items, items that did not refer to actual teaching practices (i.e., items that elicited beliefs about teaching or intent to teach in a given manner), and lists of generalized practices (e.g., "lecture", "lecture with demonstration", "multiple choice tests"). The final set of 24 items was categorized into four components (Table 2), revised for clarity and to reduce the potential of eliciting socially acceptable responses.

Intended context

PIPS items are designed for respondents to describe teaching the largest enrollment, lowest level course they have taught in the last two years. We believe this setting is one of the most challenging in which to use evidence-based instructional strategies in comparison to smaller enrollment, higher level courses. This setting is also of most concern to researchers and others involved with instructional change (AAAS, 2013).

TABLE 2. Operational Definitions and Sources of Instructional Practice Concepts Used to Develop Items on the PIPS

Component	Definition	Definition Source
Instructor-student interactions	Practices that influence the classroom relationship between the instructor and students (e.g., the role of the instructor in class sessions).	Self-generated
Student-content interactions	Practices that influence how students interact with course concepts (e.g., reflection activities, connecting concepts to students' lives).	Self-generated
Student-student interactions	Practices that influence the classroom interactions among students. These approaches include classroom discourse, small group work, and other collaborative approaches.	Self-generated
Assessment	Practices that provide feedback to students and the instructor on what, how much, and how well students are learning (Angelo & Cross, 1993). Assessment practices include what is assessed, how often students are assessed, how instructors use assessment data, and grading.	Angelo and Cross, 1993, p. 4 (modified)

Scale

PIPS uses a 5-point Likert style scale as recommended by Bass, Cascio, & O'Conner (1974), with options including: not at all descriptive, minimally descriptive, somewhat descriptive, mostly descriptive and very descriptive of my teaching. There is no neutral point on the scale in order to generate more variability in the data (Bishop, 1987; Johns, 2005).

Field testing

Face validity

An instrument has face validity if, from the perspective of participants, it appears to have relevance and measures its intended subject. This requires developers to use clear and concise language, avoid jargon, and write items to the education and reading level of the participants (DeLamater, Miles, & Collett, 2014). We pilot tested the PIPS and SCII in their entirety with a representative sample of instructors in order to achieve face validity with an interdisciplinary group of instructors. We refined items based on the feedback of these individuals prior to implementing the instruments at scale. The reader can note some of our wording changes in our previous sections on *Item Development* as relevant to the SCII and PIPS.

Content validity

Content validity requires surveys to properly represent aspects of the subject of interest (e.g,. teaching practices). A panel of subject matter experts was used to access the content validity of both SCII and PIPS (as recommended by Anastasi & Urbina, 1997). As with the pilot testing with postsecondary instructors, this process allowed for items to be evaluated for clarity and revised. New items were added, several were removed, and the structure and operational definition of each component was further developed.

Construct validity

This refers to the degree an instrument is consistent with theory (Coons, Rao, Keininger, & Hays, 2000); this is often achieved through confirmatory and/or exploratory factor analyses (Thompson & Daniel, 1996). We completed an iterative process of confirmatory and exploratory factor analyses to refine the constructs (see *Analyses).* The constructs presented in this chapter represent our thinking as of the *21st Century Transforming Institutions* conference in October 2014. As such, the constructs herein should be seen as tentative, as we are in the process of publishing on the psychometric development of each instrument.

Implementation and analysis

We collected pilot data from 889 postsecondary instructors at four institutions in the United States (Table 3). Two of these institutions (A and B) completed both PIPS and SCII, and the other institutions completed only PIPS (C and D).

Analysis followed Floyd and Widaman's (1995) recommendations for instrument development and refinement. We first ran exploratory factor analyses (EFA) using maximum-likelihood extraction with Promax rotation to identify dimensions of climate and teaching practice. We made note of items that consistently loaded together across institutions, since instructional practices and climate had the potential to manifest differently at different institutions.

We subsequently ran confirmatory factor analyses (CFA) using *SPSS AMOS 22.0* to create structural equation models based on our a priori categorization of the items and the results of the exploratory factor analyses. We refined the models based on item modification indexes and regression loadings produced by *AMOS* to reach an acceptable chi-squared/df value below 5.0, a CFI near 0.90, and RMSEA below 0.10 (Byrne, 2013). Using the SCII and PIPS constructs that emerged from the modeling process, we created individual construct scores by adding the sum of the items in each construct. Construct scores were generated only if a participant completed all of the items contributing to the construct. We

TABLE 3. Demographic and Sample Size Information for the Surveyed Institutions

	Institution A	Institution B	Institution C	Institution D
N	214	164	87	424
Departments Surveyed	13	9	10	40
Data Sources	PIPS; SCII	PIPS; SCII	PIPS	PIPS
Disciplines	STEM and Applied Sciences	STEM	Biological Sciences	All Departments
Instructors Surveyed	Full- and part-time faculty	Full- and part-time faculty	Full-time faculty only	Full- and part-time faculty
U.S. Region	Great Lakes	Mid-Atlantic	South Atlantic	Mountain West
Control	Public	Public	Public	Public
Carnegie Classification	Research university; High research activity	Research university; Very high research activity	Research university; Very high research activity	Masters College or University (larger program)
Student Population	25K	28K	34K	22K

lastly ran statistical comparisons among mean construct scores for each institution and among departments within an institution.

RESULTS

This section includes instrument reliability scores, a list of the constructs for each instrument, and select differences in institutional and department construct means. We do not include all findings to meet length requirements. In addition, we remind the reader that the constructs presented in this chapter are representative of our thinking in October 2014, and may not represent the current and finalized constructs for each instrument.

Reliability and Construct Structure

In this chapter we present the October 2014 versions of the instruments as presented at the 21st Century Transforming Institutions conference. These may not represent the final published version of these instruments. In the October 2014 versions, the SCII had 26 items within six constructs and PIPS had 20 items within five constructs. Both instruments had high internal reliability ($a > 0.8$) and could not be improved with removal of additional items (Table 4).

Climate for Instructional Improvement Means by Institution and Department

Climate for instruction improvement as elicited by SCII factored into six distinct constructs in our EFA and CFA analyses. In the order of their contribution to overall variance (Table 5), the constructs include leadership (six items), collegiality (six items), resources (three items), professional development (PD, three items), autonomy (three items), and respect (five items) (see *Appendix).*

Climate construct means significantly differed between Institutions A and B for each construct ($p < .0001$), with the exception of professional development ($p = 0.944$, Table 5). Climate means also significantly differed among departments within each institution. However, these differences were rarely significant in post-hoc comparisons. One notable exception is the significant difference in the mean leadership scores between the Mathematics Department and Industrial and Manufacturing Engineering Department at Institution A (Figure 1).

Significant differences in climate means by institution are detailed in Table 5. We also present a graph of departmental means for one of the constructs that shows instructional clusters of department means (Figure 1). In this case, we chose a plot of the leadership construct as it contributed most to overall variance (44.51% for this sample).

TABLE 4. Reliability Statistics for the October 2014 Versions of the Survey of Climate Instructional Improvement (SCII) Survey and the Postsecondary Instructional Practices Survey (PIPS)

	Survey of Climate for Instructional Improvement (SCII)	Postsecondary Instructional Practices Survey (PIPS)
Number of Items	26	20
Constructs	6	5
N	300	661
Reliability (a)	0.943	0.812

TABLE 5. Mean Climate Construct Scores by Construct and Institution, as Measured by the Survey of Climate for Instructional Improvement (SCII).

	Respect	Autonomy	PD	Resources	Collegiality	Leadership
# Items	5	3	3	3	6	6
Institution A M (SD)	2.69 (1.01)	2.75 (0.87)	3.74 (1.06)	3.08 (1.01)	2.97 (0.92)	2.65 (0.99)
Institution B M (SD)	4.25 (0.91)	4.14 (0.67)	3.75 (0.94)	4.19 (0.98)	4.03 (0.95)	4.05 (0.97)
t-test *p*-value	****	****	0.944	****	****	****

Scale. 1 = strongly disagree; 2 = disagree; 3 = somewhat disagree; 4 = somewhat agree; 5 = agree; 6 = strongly agree.

Note. **** = $p < .0001$

Instructional Practices by Institution and Department

Instructional practices factored into five distinct constructs by our EFA and CFA analyses. In the order of their contribution to overall variance (Table 6), the constructs include: instructor-student interactions (four items), student-student interactions (four items), student-content interactions, formative assessment (four items), and summative assessment (four items). PIPS items organized by construct are provided in the *Appendix*.

The instructional practice construct means significantly differed among Institutions A, B, C and D for each construct ($p < .01$, Table 6). Instructional practice means also significantly differed among departments within each institution. However, these differences were rarely significant in post-hoc comparisons. One notable exception is a significant difference in the mean leadership scores between the Mathematics Department and Industrial and Manufacturing Engineering Department at Institution A (Figure 1).

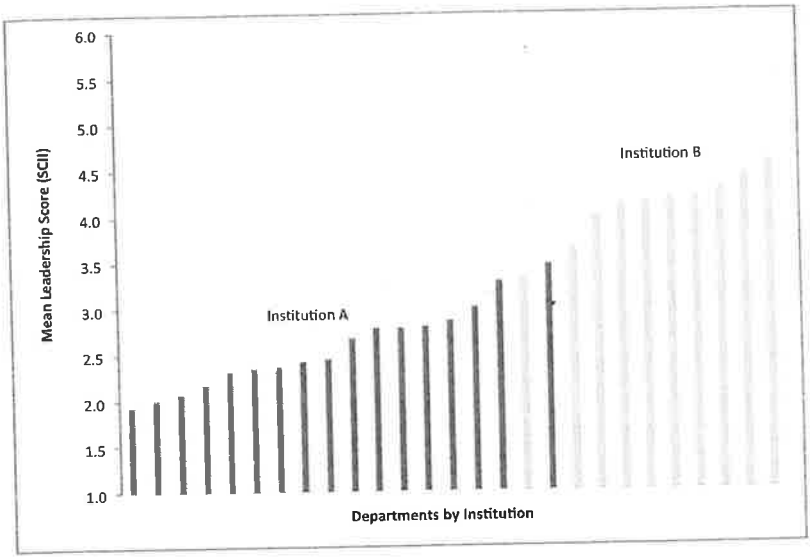

FIGURE 1. Mean leadership construct scores by department and institution as collected by the Survey of Climate for Instructional Improvement (SCII). Departments are listed in order of lowest to highest mean leadership score. Scale. 1 = strongly disagree; 2 = disagree; 3 = somewhat disagree; 4 = somewhat agree; 5 = agree; 6 = strongly agree.

Significant differences in climate means by institution are detailed in Table 5. We also present a figure that displays institutional clusters for mean department teaching practice scores (Figure 2). As with the climate constructs by department, we chose to create the figure for the construct that contributed most to overall variance (student-student interactions, 22.83% for this sample).

LESSONS LEARNED AND TRANSFERABILITY

Understanding and measuring differences in climate and teaching practices in higher education settings enables users to identify levers for improving teaching, thereby better planning future change initiatives. Our research documents support for instruments that can differentiate among elements of climate and instructional practices of postsecondary instructors. The instruments are reliable, easy-to-use, and can quickly collect data from a large number of participants. Furthermore, the instruments are designed modularly so that they can be used together or separately to understand the current situation and/or document changes over time through repeated measurements.

TABLE 6. Postsecondary Instructional Practices Survey (PIPS) Mean Scores by Construct and Institution

Summative Assessment	Formative Assessment	Student-Content Interactions	Student-Student Interactions	Instructor-Student Interactions	
4	4	4	4	4	# Items
2.23 (0.83)[d]	2.48 (0.91)[f]	1.67 (1.10)	2.36 (0.76)[e]	2.72 (0.98)[e]	Institution A M (SD)
2.09 (0.83)[d]	2.70 (0.70)[b]	1.61 (1.14)	2.55 (0.70)[e]	2.97 (0.73)[b]	Institution B M (SD)
1.62 (1.15)[a]	2.17 (1.17)[c]	1.26 (1.29)	2.21 (0.97)	2.45 (0.92)	Institution C M (SD)
2.77 (0.72)[a]	2.85 (0.67)[b]	2.55 (0.98)[a]	2.09 (0.85)[c]	2.25 (0.82)[c]	Institution D M (SD)

Scale. 0 = not at all like my teaching; 1 = minimally descriptive of my teaching, 2 = somewhat descriptive of my teaching, 3 = mostly descriptive my teaching, 4 = very descriptive of my teaching.

Note. [a] Significantly different than the other three institutions ($p < .05$), [b] Significantly higher ($p < .05$) than the two lowest scoring institutions, [c] Significantly lower ($p < .05$) than the two highest scoring institutions, [d] Significantly different ($p < .05$) than the lowest and highest scoring institution, [e] Significantly higher ($p < .05$ than the lowest scoring institution, [f] Significantly lower ($p < .05$) than the highest scoring institution.

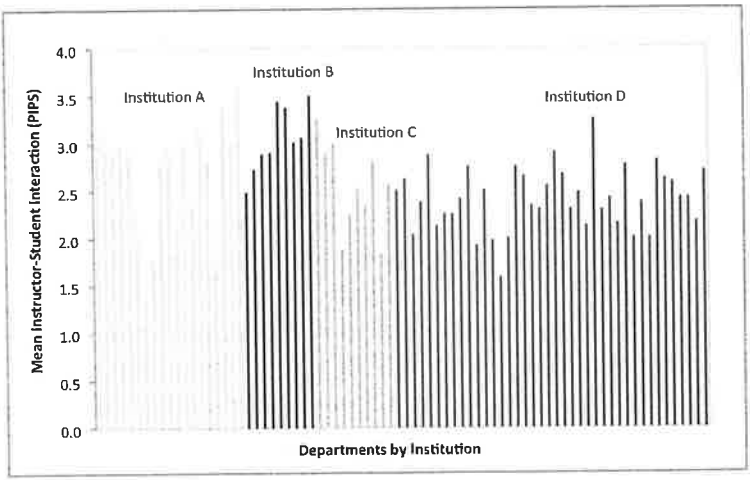

FIGURE 2. Mean instructor-student interaction scores by department and institution a collected by the Postsecondary Instructional Practices Survey (PIPS).

Scale. 0 = not at all like my teaching; 1 = minimally descriptive of my teaching, 2 = somewhat descriptive of my teaching, 3 = mostly descriptive my teaching, 4 = very descriptive of my teaching.

Unique Features of Our Instruments

Although at least 10 surveys of instructional practices (AAAS, 2013) are available, none are designed to elicit teaching practices (and only teaching practices) for an interdisciplinary group of postsecondary instructors. The survey is also non-evaluative, designed for respondents to score practices as descriptive of their teaching without judging the quality of these practices. Furthermore, PIPS is concise, non-proprietary, and designed with clear and consistent item scales.

The SCII is unlike any other instrument available. Although other instruments elicit different elements of climate including organizational climate for change (Bouckenoghe et al., 2009) and faculty teaching climate (particularly rewards and resources; Knorek, 2012), SCII is built in alignment with the essential elements of faculty work described by Gappa et al. (2007). Our results not only provide empirical support for the factors described by Gappa et al. (2007), but it also elicits constructs that could serve as levers for change in planned initiatives.

Identifying Differences with SCII and PIPS

Although not presented in detail in this paper, our findings align with those identified by other instruments. Practices in the instructor-student interaction construct were more descriptive of male instructors than female instructors. This construct includes practices such as "students sitting and taking notes" and "teaching with the assumption that students have little incoming knowledge." Henderson, Dancy, and Niewiadomska-Bugaj (2012) and Kuh, Laird, and Umbach, (2004) likewise found women using fewer instructional practices of this nature.

We also found rank-based differences in teaching practices and in perceptions of department climate similar to those in the literature. For example, part-time instructors reported less flexibility in their teaching methods and fewer teaching resources than their tenure-track counterparts (e.g. Gappa & Leslie, 1993). Graduate students were also less likely to claim assessment practices (both formative and summative) were descriptive of their teaching, perhaps due to a lack of autonomy to develop these assessment practices.

Unique to our study are institutional clusters in teaching practices and organizational climate for instructional improvement (e.g. Figure 1). These clusters may indicate that some elements are more normative at the institution level than the department level, with the exception of certain disciplines. Institution A, which is less research intensive than Institutions B and C by Carnegie classification, reported using more instructor-student interactions. We also found a significant negative correlation ($p<0.01$) between traditional teaching practices

and evidence-based teaching practices, which supports the logical argument that use of one relates to less use of the other.

Future Work

One of our next steps will be to complete hierarchical linear models to understand the sources of variance within the data. This will identify contributions to variance at levels higher than the individual, including department and institution-level variance.

We will also be triangulating the results of our instructional practices survey with teaching observation data (collected using the TDOP) and interviews with instructors. These observations will provide additional support for our constructs and help gain further insight into their organizational climate and undergraduate instructional practices.

Access to the instruments

The instruments are available in their full pilot versions and with items organized into constructs from our website: http://homepages.wmich.edu/~chenders/Publications/. We request that if you plan to use the instruments, please use them in their entirety and please share the data with our research team for further refinement of the instruments.

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