STEM vs. Non-STEM Cultures in a R1 University

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Science, technology, engineering, and math (STEM) academic departments are expected to promote cutting-edge education supported by rapidly changing curriculum. Despite perceptions and assumptions for embracing innovation, funding agencies continue to target major educational reform in STEM disciplines, suggesting a lack of success. Research suggests difficulty in implementing curriculum change may be due to a non-innovative organizational culture. We examined whether the organizational culture of STEM academic departments is less change-oriented than assumed, which might explain the constant need for overhauling curriculum. Findings have implications for future funding decisions, STEM departments, and pedagogy in the discipline.

Keywords: culture, STEM education, organizational change

INTRODUCTION

Science, technology, engineering, and mathematics (STEM) disciplines are considered hubs for innovation and problem-solving (e.g., https://www.ed.gov/stem). As such, one might assume these academic departments embrace change and risk-taking in problem-solving. Yet, despite a history of funding by various agencies, such as the National Science Foundation (NSF), to support the development of novel teaching mechanisms (e.g., National Research Council, 2012; Pollard, Hains-Wesson, & Young, 2018), which ultimately improve enrollment and retention in STEM (especially women and minorities; see National Science Foundation News Release 18-049; Stains et al., 2018), these agencies still aggressively fund improvements in STEM as if past efforts have been unsuccessful. For example, since 2006 the Engineering Education Commission (EEC) of NSF has awarded over 600 million U.S. dollars toward improving engineering education in public and private institutions of higher education, with about $40 million of those funds aimed at revolutionizing pedagogy (see www.nsf.gov/awards). The amount of money dedicated to improvements in engineering education suggests that even for disciplines with a reputation for innovation, changing curriculum is not easy.

This apparent difficulty in implementing curriculum change may be linked to research suggesting that organizational culture plays a significant role in whether or how change is embraced (e.g., Lee, 2007; Schneider, Brief, & Guzzo, 1996; Wieman, Perkins, & Gilbert, 2010); yet it appears few, if any, researchers have investigated how faculty within these disciplines view their own departmental cultures.

Namely, if faculty perceive their culture as rewarding uniformity or stability over change, innovations in teaching are unlikely to take hold or survive beyond novel initiatives and grant funded agendas.

Although the initial instigation for the current study was to understand the continued need for education reform in engineering departments, the study objectives were expanded to include both STEM and non-STEM disciplines more broadly, recognizing the challenge of improving education to retain students in higher education, especially those from underrepresented populations, is not limited to engineering (e.g., Gentry, 2014). Therefore, the purpose of this study was to explore how departmental culture is perceived with respect to innovation, openness to change, and rigidity by those teaching in the discipline. The supposition here is that if STEM cultures are considered innovative, challenges other than the organizational culture must be inhibiting curriculum change. If the culture is not perceived as embracing change, this may be one factor in explaining failure of sustainable curriculum change, and society may be better served by making organizational culture change a *primary* consideration in funding decisions for improvements in higher education, rather than a secondary concern. Additionally, if non-STEM cultures are as open to change as STEM, or more so, STEM disciplines may be able to learn from non-STEM cultures to achieve greater education reform. To realize the study objective, the organizational cultures of STEM and non-STEM departments in a mid-sized western U.S. R1 university (i.e., doctoral university with very high research activity; Carnegie, 2018) were examined and compared.

BACKGROUND

Organizational culture refers to the norms, patterns of behavior, attitudes, and assumptions that those within the organization adhere to and sustain (Hofstede, 1998; Ostroff, Kinicki, & Muhammad, 2013; Schneider, 2000). As such, culture is socially created and maintained by employees (Hofstede, 1998; Meek, 1988). Culture determines behavior; the often unspoken, yet well understood rules regarding which behaviors are allowed and not allowed (Meek, 1988). Importantly, organizational culture forms the boundary conditions within which change is either fostered or constrained (e.g., Johns, 2006). Hence, if efforts to improve teaching within STEM disciplines are to be successful, the culture must support faculty members' actions to innovate and adopt new methods of teaching.

Researchers in the organizational sciences distinguish between culture, a concept residing at the organizational level, and climate, a concept more closely tied to the motivation and behavior of individuals (Hofstede, 1998; Ostroff et al., 2013). Climate is said to focus on the immediate context, the temporary situation that forms one's current subjective experience (Ostroff et al.). In contrast, culture defines why the contextual environment exists as it does; an evolved context more perpetual than climate (Ostroff et al.). Because this study focused on the longstanding experience of values, meaning, and potential boundary conditions of behavior, perceptions about culture rather than climate were examined.

Culture of STEM and Non-STEM Disciplines

It appears not much has been published on the organizational structure of STEM vs. non-STEM disciplines, which informs our examination of organizational culture. Anecdotally, STEM disciplines in research-active universities embody cultures where funding from external agencies is required for legitimacy. Standards of practice, including choice of research topic, are to a degree informed by these external funding agencies through their initiatives and award criteria. Internal structures and policies, such as laboratory space or criteria for promotion and tenure, result from the value, support, and reward for grant production, competition, and publications (Fairweather, 2008; Menachemi, Morrisey, Au, & Ginter, 2009). In contrast, non-STEM disciplines within the same universities are typically not required to obtain funding from external agencies to advance their fields; though many seek grants to enhance the undergraduate experience (e.g., Andrew W. Mellon Foundation, Teagle Foundation).

To date, differences between STEM and non-STEM disciplines have been primarily examined in the context of diversity, specifically focusing on gender disparity (e.g., Xu, 2008) and comparing graduation rates. For example, Mitchneck, Smith, and Latimer (2016) suggested a barrier to culture change aimed at attracting and retaining females in the sciences may be based in the promotion and tenure process.

Specifically, within STEM disciplines, securing promotion and tenure demands competition for external funding and high publication rates, both of which inherently work against women due to work-life balance challenges (e.g., Wolfinger, Mason, & Goulden, 2008). Hrabowski (2014), and Elrod and Kezar (2017) examined graduation rates for students interested in STEM versus non-STEM education and found non-STEM disciplines better at retaining students than STEM disciplines. Additionally, Nelson Laird, Shoup, Kuh, and Schwarz (2008) found that students in non-STEM disciplines were significantly more exposed to higher-order, reflective, and integrative learning strategies than those in STEM disciplines.

Thus, after an extensive literature search, we found little in the way of theoretical frameworks to guide hypotheses of differences or similarities between STEM and non-STEM cultures outside of existing examinations of diversity and retention amongst undergraduates. Hence, questions regarding whether an innovative department culture supports higher education curriculum change have gone unanswered. The answers to questions like this have implications for funding, as well as for previous findings regarding pedagogy. For example, if university administrators begin requiring non-STEM departments to compete for grant funding to support their budgets, understanding the culture of STEM departments might shed light on creating a culture with norms for securing external funding. Additionally, given evidence that faculty in non-STEM disciplines use more higher-order learning strategies in the classroom than do faculty in STEM, the differences between STEM faculty and non-STEM faculty perceptions of culture may explain how the teaching strategies in STEM can be changed to support higher-order learning. Lastly, students are affected by departmental culture; thus, how faculty perceive and sustain their organizational culture might help explain challenges in student retention rates in STEM. For instance, higher retention rates in non-STEM disciplines might be partially attributed to the culture. Therefore, STEM departments may benefit from understanding whether or how their culture differs from non-STEM.

Specific Constructs of Interest

To determine whether those within STEM disciplines perceive their cultures as more innovative and open to change than those in non-STEM disciplines, perceptions of organizational culture (i.e., innovative, supportive, or bureaucratic), dispositional resistance to change, and degree to which learning organization dimensions exist (Argyris & Schön, 1978) were examined in this study. These constructs were chosen because, collectively, support for an innovative culture, low resistance to change, and engaging in learning organization principles would provide strong evidence that STEM cultures are perceived similarly to anecdotal descriptions, and that difficulties with curriculum change should not automatically be attributed to the culture. Each construct is discussed next.

Organizational Culture

Though a number of taxonomies of organizational culture exist (e.g., Ostroff et al., 2013), a three-component model with potential for conceptual linkage to innovation versus inclination towards stagnation was chosen as the organizational culture framework for this study. Specifically, Wallach (1983) combined the works of Margerison (1979) and Litwin and Stringer (1968) to suggest organizational culture comprises three dimensions: bureaucratic, innovative, and supportive, where the culture is represented as a blending of the three. The bureaucratic dimension characterizes a culture that embraces hierarchy and procedures, valuing structure, order, and regulation. A culture stronger on the bureaucratic dimension than either innovative or supportive is distinguished by stability and tendency towards complacency or stagnation (Wallach, 1983). Organizations whose members report high scores on innovation as compared to the other two dimensions are characterized by creativity, risk-taking, and challenge. Innovative cultures emphasize novelty and results. Lastly, Wallach described the supportive culture as one where relationships are important, and trust, encouragement, and collaboration are highly valued. Thus, an organization whose members endorse the supportive dimension over innovative and bureaucratic is considered a safe and collaborative (less competitive) place to work. Consistent with anecdotal evidence and given societal assumptions and expectations for STEM disciplines, those in STEM departments are expected to endorse the innovative dimension over supportive or bureaucratic, and non-STEM disciplines are expected to endorse supportive over innovative or bureaucratic dimensions of culture.

Hypothesis 1: *STEM disciplines endorse the innovative culture significantly more than either the supportive or bureaucratic cultures, which are more highly endorsed by non-STEM disciplines.*

Resistance to Change

Literature on organizational culture change typically includes a discussion of employees' resistant to change, which threatens the success of interventions (e.g., Erwin & Garman, 2010; Lines, 2004; Oreg, Bartunek, Lee, & Do, 2018). When considered as a stable disposition across members of an organization, collective resistance to change can minimize the potential success of change efforts. High cognitive rigidity and preference for low levels of novelty are characteristic of individuals reporting a high resistance to change (Oreg, 2003). A damaging implication of high resistance to change is that efforts to improve teaching, which could ultimately affect graduation rates or graduates' preparedness for future careers in STEM, may be unsuccessful. Given that STEM disciplines are anecdotally considered innovative, growth oriented, and constantly changing, they should be characterized as lower in resistance to change than non-STEM.

Hypothesis 2: *Non-STEM disciplines are characterized by a higher resistance to change than STEM disciplines.*

Learning Organization

The last construct of interest in the current study is the learning organization. A learning organization is one where employees create and share knowledge, thereby generating a self-sustaining culture of continuous growth (Argyris & Schön, 1978). According to Senge (1990), the learning organization comprises employees with an emphasis on team learning and shared visions that encourage participation in achieving an overall goal, mental models or shared perspectives on how things are done, personal mastery that embraces growth, and system thinking to see connections. Seven dimensions are necessary for building a learning organization (Senge, 1990): continuous learning (people can learn on the job), inquiry and dialogue (people gain reasoning skills), team learning (groups learn together), technical systems for learning (technology is used to share work), empowerment (people create a joint vision), system connection (people connect their work to the bigger organization), and strategic leadership (champion).

Although researchers suggest it takes time, effort, commitment, and leadership to create a learning organization (e.g., Garvin, 1993), it is proposed here that STEM disciplines are more likely to endorse having the principles for a learning organization than are non-STEM disciplines because STEM faculty members' often orient themselves around working in research groups (especially where large labs are required), continuously seeking interdisciplinary partners to obtain grant funding, and they collaborate with and empower others to secure external funding for necessary laboratory space and equipment.

Hypothesis 3: *Members of STEM disciplines endorse having the principles of a learning organization more than members of non-STEM disciplines.*

METHOD

Participants and Procedures

From a single university, participants were recruited from four STEM departments, two in the College of Engineering and two in the College of Natural Sciences, and two non-STEM departments in the College of Liberal Arts. STEM departments included Electrical and Computer Engineering (ECE), Mechanical Engineering (MECH), Biochemistry and Molecular Biology (BCMB), and Physics. Non-STEM departments included Communication Studies (COMM) and English. Participants were notified of the study by their Department Chair, after which each participant received an individual email invitation from the researchers with a link to the secure online survey. Participants received informed consent and were offered $20 for their voluntary participation in the study.

Demographics for the participants and their representative departments are shown in Table 1 and Table 2. Overall, the study samples were proportionately similar to their respective department populations, with minor exceptions. Additionally, due to the low response rate from Physics, their responses were dropped from analyses. Later discussions with a few faculty members in Physics revealed their low participation was due to recent changes in leadership accompanied by difficult departmental politics.

TABLE 1
DEMOGRAPHICS OF STUDY SAMPLE

	STEM				Non-STEM	
	ECE	MECH	BCMB	Physics	Comm.	English
# Recruited	59	52	28	37	40	85
# Participated	45	28	17	7	19	45
Response rate	76%	54%	61%	19%	48%	53%
Sex	11F (24%) 31M (69%) 3 missing	6F (22%) 19M (70%) 2 missing	6F (35%) 10M (59%) 1 missing	2F (22%) 5M (78%) 0 missing	14F (74%) 5M (26%) 0 missing	33F (73%) 12M (27%) 0 missing
Mean Age in years	48.60	45.48	51.13	49.14	39.95	46.10
Age *SD*	11.77	10.81	8.96	15.80	11.45	11.73
Assistant	2	4	3	0	5	6
Associate	6	6	5	0	2	8
Full	18	5	7	2	2	7
Instructor	2	3	0	1	6	20
Staff	7	5	0	4	4	4
Research Associate	10	4	2	0	0	0
Missing job type	0	0	0	0	0	0

Note. ECE = Electrical & Computer Engineering; MECH = Mechanical Engineering; BCMB = Biochemical & Molecular Biology; Comm = Communications.

TABLE 2
DEMOGRAPHICS OF DEPARTMENT POPULATIONS

	STEM				Non-STEM	
	ECE	MECH	BCMB	Physics	Comm.	English
N	59	52	28	37	40	85
Sex	10F (17%) 45M (76%) 4 missing	8F (15%) 37M (71%) 7 missing	9F (32%) 16M (57%) 3 missing	8F (22%) 27M (73%) 2 missing	29F (72%) 11M (28%) 0 missing	63F (74%) 22M (26%) 0 missing
Mean Age in years	50.61	49.83	51.00	50.76	39.77	48.35
Age *SD*	12.40	16.63	10.68	14.29	9.01	12.19
Assistant	2	7	4	4	9	10
Associate	6	9	8	7	4	13
Full	18	18	9	8	5	13
Instructor	4	4	0	2	15	40
Staff	7	8	0	10	7	9
Researcher	22	6	7	3	0	0
Missing job type	0	0	0	3	0	0

Measures

All reported reliabilities were obtained on the study sample. All scales were evaluated using confirmatory factor analysis (CFA) with good fit determined using Hu and Bentler's (1999) suggested cutoffs of root mean square error of approximation (RMSEA) below .06, significant Chi-Square statistic (χ^2), Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI) of above .95, and a standardized root mean square residual (SRMR) below .08.

Organizational Culture

Wallach's (1983) index of organizational culture was used to assess faculty and staff members' perceptions of their department's organizational culture. The measure comprises 24 adjectives rated on a 0 = "not at all like my organization" to 4 = "describes my organization most of the time" response scale, for which "organization" was changed to "department." The scale assesses perceptions of three types of culture: innovative (α = .79), supportive (α = .85), and bureaucratic (α = .76). Each type of culture is assessed by eight behavioral words (e.g., innovative: risk taking, supportive: collaborative, bureaucratic: hierarchical). According to Wallach, cultures are a combination of the three categories, with the dominant orientation reflected by the highest score. CFA results for a 3-factor solution indicated less than ideal fit, though better than a 1-factor solution (Table 3).

Since organizational culture represents a construct indicating shared norms of the group, researchers must demonstrate that individual raters of the culture agree on their ratings before using the results as an indicator of the culture. Therefore, inter-rater agreement using the $r_{WG(J)}$ statistic (LeBreton & Senter, 2007) whereby a statistic close to 1.0 indicates high agreement was calculated. The $r_{WG(J)}$ statistic indicated high agreement on innovative, bureaucratic, and supportive dimensions for both STEM departments ($r_{WG(J)}$ = .95, .95, .95) and non-STEM departments ($r_{WG(J)}$ = .96, .96, .96), respectively.

Resistance to Change

Oreg's (2003) 17-item scale to assess dispositional resistance to change with a response scale of 1 = "strongly disagree" to 6 = "strongly agree" was used. Feedback from a pilot test of the survey indicated two scale items did not apply because of the different types of positions held by participants within and across departments (i.e., teaching only, research only, staff); therefore, the following two items were removed: "When someone pressures me to change the way I teach, I tend to resist even if I think the change may ultimately benefit me" and "When someone pressures me to change the way I do my research, I tend to resist even if I think the change may ultimately be beneficial." Oreg (2003) demonstrated the scale can be used either as a single overall scale score or separate dimension scores. With no theory or empirical rationale to hypothesize differences between groups on any of the sub-factors of resistance to change, a single overall scale score was used. CFA results supported a 1-factor solution (Table 3). Coefficient alpha on the 15-item scale was acceptable ($\alpha = .86$).

Learning Organization

To assess Senge's (1990) seven dimensions of learning organizations, Marsick and Watkin's (2003) 43-item scale was used. In a pilot test of the survey, participants reported two problematic items: "My department chair/head continually looks for opportunities to learn" and "My department measures the results of the time and resources spent on training." Because of the phrasing of the first item, participants could not answer the question – they had no insight into what the department chair does. The second item did not fit in this context as training is optional and tracked in human resources; making the question irrelevant for the academic departments we studied. Therefore, both items were dropped resulting in a total of 41 items. CFA results indicated one item, "research areas are confident that the department will act on their recommendations" showed cross-loading on both team learning and systems for learning to provide the best fitting 7-factor solution, which was superior to a 1-factor (see Table 3), though still less than ideal. Five dimensions of the seven-dimension scale comprised six items each (i.e., inquiry & dialogue, team learning, systems for learning, empowerment, system connection), one dimension comprised five items (i.e., strategic leadership), and one dimension had seven items (i.e., continuous learning), creating the 7-factor solution. Responses were reported on a 7-point scale ranging from 0 = "never" to 6 = "always; every day." Alpha reliabilities for each dimension are shown in Table 4.

TABLE 3
FIT STATISTICS FOR STUDY VARIABLES

Variable	χ^2 *(df)***	CFI	TLI	RMSEA	90% CI RMSEA	SRMR
Culture (1 factor)	961.05 (253)	.545	.504	.132	[.123, .141]	.140
Culture (3 factor)	440.60 (202)	.830	.806	.086	[.975, .097]	.129
Resistance to change	114.49 (51)	.907	.879	.090	[.068, .112]	.062
LO (1 factor)	2314.95 (779)	.649	.630	.111	[.105, .116]	.093
LO (7 factor)	1387.70 (754)	.855	.842	.072	[.066, .078]	.071

Note: LO = Learning Organization; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; ***p* < .01

RESULTS

Scale means and standard deviations appear in Table 4. Although correlations between constructs were not examined, they are provided as standard practice to make sense of the data collected and reported findings, along with alpha reliabilities on the diagonal in Table 4. The reported cultures of STEM and non-STEM departments were compared using analysis of variance (ANOVA). STEM and non-STEM were comprised of different numbers of participants (i.e., 90 vs. 64, respectively), therefore the Levene statistic for test of homogeneity of variance was included within the ANOVA. For those variables where assumptions of equal variance were violated, findings from independent sample t-tests with equal variances not assumed are reported instead. We adhered to $p < .05$ as the cutoff for statistical significance. Means and standard deviations for the comparisons between STEM and non-STEM disciplines are shown in Table 5.

Results show STEM department cultures were rated as significantly more supportive than innovative (t (89) = -7.56, p < .000) or bureaucratic (t (89) = -15.59, p < .000). Non-STEM participants reported perceptions of having a significantly more bureaucratic culture than STEM participants (t (151.97) = 5.64, p < .000). There were no significant differences in STEM and non-STEM respondents' perceptions on culture as supportive (F (1,152) = 2.79, p = .10) or innovative (t (149.84) = -.58, p = .56). Findings were not consistent with Hypothesis 1.

There were significant differences in resistance to change (F (1,144) = 4.03, p = .047), with non-STEM reporting a higher level of resistance than STEM (Table 5). These results, consistent with Hypothesis 2, suggest that those in STEM disciplines may be more likely to embrace or seek change than their non-STEM peers.

Results also indicate significant differences between STEM and non-STEM on the learning organization dimensions of system learning (F (1,90) = 6.68, p = .01), continuous learning (t (145.46) = 4.77, p < .00), and inquiry and dialogue (t (151.75) = 2.20, p = .03), with non-STEM reporting higher means. Other dimensions: system connection (t (146.84) = 1.97, p = .05), empowerment (t (149.56) = 1.37, p = .17), team learning (F (1,91) = 3.48, p = .07), and strategic leadership (F (1,148) = 2.99, p = .09) were not significantly different between STEM and non-STEM. Although only three out of the seven dimensions were significantly different (three with p-values close to cutoff), all means were visibly higher for non-STEM (see Table 5), suggesting that contrary to Hypothesis 3, non-STEM endorsed learning organization principles more than STEM.

TABLE 4
DESCRIPTIVE STATISTICS AND CORRELATIONS BETWEEN VARIABLES

	Variable	M	SD	1	2	3	4	5	6	7	8	9
1.	Sex	1.48	0.50	--								
2.	Age	46.47	11.54	-.27**	--							
3.	Inn	17.45	4.70	.05	-.05	(.79)						
4.	Supp	22.29	5.19	.09	-.07	.64**	(.85)					
5.	Bur	15.96	4.19	.19*	-.06	.04	.04	(.76)				
6.	Res	2.94	0.63	.08	-.20*	.02	-.03	.06	(.86)			
7.	LO-inq	3.79	1.11	.08	-.12	.52**	.71**	.12	.04	(.91)		
8.	LO-cont	3.39	1.12	.22**	-.20*	.56**	.60**	.18*	.11	.78**	(.90)	
9.	LO-team	3.71	1.11	.11	.02	.44**	.57**	.13	.17	.61**	.56**	(.83)
10.	LO-syslrn	2.77	1.16	.16	.05	.49**	.49**	.28**	.04	.56**	.54**	.60**
11.	LO-emp	3.43	1.12	.05	.02	.55**	.65**	.06	.01	.67**	.58**	.61**
12.	LO-syscon	3.51	1.11	.19*	-.08	.53**	.57**	.11	-.02	.65**	.63**	.60**
13.	LO-strat	3.87	1.21	.10	-.10	.51**	.59**	.12	-.05	.52**	.50**	.54**

	Variable	10	11	12	13
10.	LO-syslrn	(.87)			
11.	LO-emp	.70**	(.89)		
12.	LO-syscon	.65**	.71**	(.87)	
13.	LO-strat	.62**	.71**	.65**	(.90)

Note. Sex is coded as 1 = male, 2 = female; Inn = innovative culture; Supp = supportive culture; Bur = bureaucratic culture; Res = resistance to change; LO-inq = learning organization inquiry & dialogue; LO – cont = learning organization continuous learning; LO-team = learning organization team learning; LO-syslrn = learning organization systems learning; LO-emp = learning organization empowerment; LO-syscon = learning organization system connection; LO-strat = learning organization strategic leadership. Alpha reliabilities are along the diagonal in parentheses.

* $p < .05$, ** $p < .01$

TABLE 5
MEANS FOR STEM AND NON-STEM DISCIPLINES

Variable	STEM *M (SD)*	Non-STEM *M (SD)*
Organizational Culture: Innovation	17.63 (5.10)	17.20 (4.08)
Organizational Culture: Supportive	21.70 (5.36)	23.11 (4.86)
Organizational Culture: Bureaucratic	**14.57 (4.34)**	**17.92 (3.04)**
Resistance to Change	**2.85 (0.64)**	**3.06 (0.60)**
Learning-organization: inquiry & dialogue	**3.63 (1.25)**	**4.00 (0.85)**
Learning-organization: continuous learning	**3.07 (1.24)**	**3.83 (0.72)**
Learning-organization: team learning	3.62 (1.11)	4.21 (0.93)
Learning-organization: systems for learning	**2.64 (1.11)**	**3.49 (1.26)**
Learning-organization: empowerment	3.33 (1.26)	3.57 (0.87)
Learning-organization: system connection	3.37 (1.22)	3.71 (0.92)
Learning-organization: strategic leadership	3.73 (1.30)	4.08 (1.07)

Note. Significant differences ($p < .05$) between STEM and non-STEM disciplines are highlighted in bold.

DISCUSSION

STEM departments reported a significantly less bureaucratic culture than non-STEM, which although not an endorsement for a more innovative or change-oriented culture, the findings are an indication that STEM departments do not actively stifle variability in behavior. Bureaucracy, as originally described by Weber (1947), removes ambiguity by clarifying who reports to whom, ensures fairness by connecting salary amounts to position descriptions rather than to a person per se, and establishes rules that encourage and reward consistent ethical behaviors. The extent to which respondents view their department as consistent with bureaucracy, the less variability in behavior and risk-taking in that department. In addition, non-STEM respondents reported higher resistance to change than did STEM respondents, suggesting STEM are more open to change. These results along with the significantly lower ratings of a bureaucratic culture for STEM over non-STEM seem in line with anecdotal statements about the creative, innovative, and risk-taking nature of STEM disciplines. Yet, despite these results, STEM respondents did not endorse their cultures as significantly more innovative than non-STEM.

To make sense of these findings, the structure of the departments at the R1 University from which they were recruited was taken into consideration. The non-STEM departments have more non-tenure track (NTT) faculty than STEM. NTT (e.g., labeled “instructors” in the tables) faculty are typically hired on a contract that documents reporting structure and criteria for contract renewal. Their salaries are fixed within a range, depending on number of courses taught and the instructor’s educational level. In contrast, within STEM the majority of faculty were tenured with no documented pre-determined range for salary and a loosely defined chain of authority. Although the overall sample included both NTT and tenure-track faculty members as well as staff, within the non-STEM departments more than 50% of faculty members are NTT (i.e., 53% in English, 55% in Communication), compared to 0%, 8%, and 9% in ECE, MECH, and BCMB, respectively, which likely affects cultural norms and values; a perspective not considered prior to data collection. Thus, given the contractual nature of NTT-heavy departments in non-STEM, it makes sense those respondents would consider their culture more bureaucratic. Furthermore, one can speculate the lower levels of resistance to change reported by STEM respondents as compared to non-STEM might reflect the constant reshaping of field, tasks, grant applications, and teaching obligations required by ever-changing technological advancements in STEM fields (Deming & Noray, 2018; Raupp, 2018).

Both STEM and non-STEM respondents rated their cultures more supportive than innovative or bureaucratic, indicating a possible influence from the overall university culture leaning more towards an environment marked by respect, trust, and collaboration (Wallach, 1983). These results are somewhat refreshing because although a less bureaucratic culture might suggest room for risk-taking, researchers have shown such cultures disadvantage newcomers to the field who are typically women or members of underrepresented groups, particularly in the sciences (Roth & Sonnert, 2010).

Overall, the findings contribute to answering the question of whether those in STEM and non-STEM view their departmental cultures similarly. Although more data are needed across universities, as well as within STEM and non-STEM departments, to answer the question fully, this study may be a first to shed light on this question.

Drawing only from the culture and resistance ratings, the findings suggest that STEM faculty may indeed view their culture as accepting of and embracing change, but not necessarily more than their non-STEM peers. A supposition at the start of the project was that if those in STEM did not view their departmental cultures as reflective of the risk-taking and innovative disciplines they represent, that failure to make curriculum changes might be attributed to a restrictive organizational culture. However, the findings do not support this basic supposition. First, there may be other taxonomies of culture than the simple one used here, which better capture inhibitors to change. Second, openness to curriculum change itself was not assessed, which might be different than openness to innovation in the discipline.

With regards to learning organization principles, contrary to expectations, respondents in non-STEM disciplines rated three out of the seven dimensions higher than did respondents in STEM disciplines. It was hypothesized that STEM disciplines would report higher means due to their tendency to focus on research teams and their likelihood to engage in more collaborations across funding and research endeavors than non-STEM. It may be that respondents pursuing specialized collaborations in STEM unintentionally isolate themselves within the department, which reduces their capacity to inquire about others' work efforts, support global opportunities for learning, or engage in system changes that connect people in the department.

Implications, Strengths, Limitations, and Future Research

The results have implications for theory and practice. The findings suggest the organizational culture taxonomy used in this study is not ideal for academe. In particular, the simplicity of three categories that together describe the organizational culture may ignore important dynamics of higher education such as subcultures within departments and the unique structure of fluid lines of responsibility and authority found in academe. However, other culture indexes did not seem general enough to fit the language and structure of academe. For instance, the Competing Values Framework (Quinn & Cameron, 2006) that describes organizational effectiveness along two dimensions, or Deal and Kennedy's (1996) Risk versus Speed of Feedback organizational effectiveness model do not fit the study objective (c.f., Smart & Hamm, 1993). Though Schein (1990) and Trice and Beyer (1993) provided explanations for what to measure to obtain a rich understanding of culture (e.g., artifacts, values, symbols, narratives), they do not offer a framework or instruments for comparing cultures. Going forward, researchers should consider developing taxonomies of organizational culture specific to academia or potentially leveraging results from studies of hospitals, as they are considered similar structures to higher education (e.g., Balotsky, 2018).

A broad practical implication of the findings is that organizational culture may not be inhibiting curriculum change attempts in non-STEM or STEM departments. Thus, STEM faculty *should* be able to change their teaching to incorporate higher-order learning in the classroom (Nelson Laird et al., 2008), and non-STEM faculty *should* be able to incorporate norms for competing for grant funding like their STEM peers. That said, whether aspects of culture other than those studied here inhibit change must be addressed by future research.

A strength of this study is the inclusion of different departments across STEM and non-STEM disciplines and across colleges within the same university. By examining both STEM and non-STEM, as well as comparing STEM across two different colleges, a determination of whether the responses were unique to their college culture, department, or common across the university could be made. Additionally, included in the sample were faculty members (tenure-track and non-tenure track) and staff, making the culture assessments a more accurate representation of the departments as a whole. Although staff may not be directly involved in curriculum change, they are active members of the culture, helping to maintain and support the boundary conditions created by norms and sustained by policies and procedures.

Since an examination of the relationships between constructs (i.e., correlations) was not made, the conclusions from the ANOVAs are not affected by method bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003), which threatens the validity of conclusions by attributing part of the variance found in results to the measurement method rather than to actual relationships between the constructs being measured. For example, had the correlations of the study been used to infer relationships between the measured constructs, such as whether the culture is significantly related to level of resistance, those findings would be suspect to method bias. Readers choosing to use the correlations obtained here for future studies should be aware that such use and conclusions derived from those analyses are subject to method bias.

Lastly, in this study, the focus was on a R1 U.S. mid-sized institution, thus limiting the generalizability of results to other non-R1 universities. However, studying a single institution ensured respondents were subject to the same overall university culture. The emphasis on research and obtaining grant funding at R1 universities is notably different from master's or baccalaureate only colleges (Carnegie, 2018), which likely factors into culture perceptions. Future studies should examine non-R1 university disciplines to determine the extent to which the findings from this study can be replicated, as well as identify whether noted differences between institution categories actually matters in culture assessments or educational reform efforts.

CONCLUSION

Although some differences between STEM and non-STEM disciplines were found, the results suggest the disciplines are perceived similarly, in terms of culture, by their members. Overall, the culture of STEM departments was perceived as less bureaucratic and less resistant to change, which should have translated into a higher endorsement of innovative culture. This research contributes to the higher education literature by broadening our understanding of culture perceptions, similarities, and differences between STEM and non-STEM disciplines. Future studies may incorporate a rich and detailed examination of subcultures within STEM to shed additional light on the findings of this study.

In general, the findings may suggest that organizational culture is not the sole explanation for why some efforts to revolutionize higher education in STEM disciplines appear unsuccessful – or at least why funding agencies like NSF believe more efforts are still necessary. For example, Nevenglosky, Cale, and Aguilar (2019) suggest concerns regarding buy-in to reform and that pilot testing curriculum before full implementation to gain teacher buy-in might lead to more successful education reform. It may also be that aspects of the culture other than what were studied here are the primary inhibitors to curriculum change. No doubt, additional research on STEM vs. non-STEM disciplines, specifically their organizational cultures, could provide much needed answers toward improvements in higher education overall.

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