Exploring interactions of race and discipline in teaching practices: Focusing on faculty of color in STEM

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Abstract

Within the context of efforts to improve student learning experiences by improving pedagogical practices, particularly in STEM disciplines, this study seeks to center the experiences of faculty of color to better understand how diverse faculty approach teaching in different disciplines. Using a large-scale, multi-year data set and multilevel, random-slope modeling, this study looks at the relationship between faculty use of active learning and the importance of reflective and integrative learning in their courses, and how those relationships vary across disciplines for faculty of color. Results indicate a significant, positive relationship, significant variations across disciplines for Black or African American, Hispanic or Latino/a, and faculty of another identity, and substantial overlap in teaching practices between STEM and non-STEM faculty of color.

Keywords: pedagogy, faculty of color, STEM, disciplinary differences

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There is a major call to action in higher education for Science, Technology, Engineering, and Mathematics (STEM) educators to reexamine their pedagogical practices. Reasons for the urgency to reexamine pedagogy include better preparing STEM professionals for the workforce, increasing minority group representation in STEM, which often lags minority representation in non-STEM disciplines, and improving equity in STEM environments (Beach, Henderson, & Finkelstein, 2012; Hurtado, Newman, Tran, & Chang, 2010; Johnson, Ong, Ko, Smith, & Hodari, 2017). STEM national organizations, such as the National Science Foundation (NSF), Accreditation Board for Engineering and Technology (ABET), and National Academies of Science (NAS), have created new initiatives to enhance undergraduate learning experiences by improving teaching (Fairweather, 2008). Some of the proposed pedagogical changes include creating more interactive and engaging classrooms through collaborative work and adjusting educational goals to improve students' conceptual understandings (Beach et al., 2012).

Researchers and educators alike have taken this call to action a step further to understand how STEM environments can become more culturally relevant and inclusive, specifically to help improve minority representation (Dewsbury, 2017). However, there continues to be a perceived dissonance between culturally relevant concepts and STEM environments (Haynes & Patton, 2019). Furthermore, STEM faculty find difficulty in incorporating culturally-related pedagogy due to a lack of training, time, and reward structures in place to recognize transformative efforts (Dewsbury, 2017; Haynes & Patton, 2019; Jett, 2013; Moriarty, 2007; Salazar, Norton, & Tuitt, 2010). However, the perceived barriers to implementing culturally relevant and inclusive STEM environments may not be as widespread, as faculty of color found ways to prepare and support students in often hostile STEM environments (Griffin, Perez, Holmes, & Mayo, 2010). This points to a need to further investigate how important STEM faculty of color believe providing a more relatable and supportive environment for students of color in STEM translates to their pedagogical practices. We aim to investigate this point by examining the pedagogical approaches of STEM faculty of color, as well as those approaches of non-STEM faculty of color, to more broadly understand how faculty of color approach their teaching and how it differs across disciplines.

Conceptual Underpinnings

Cognitive Theories of Learning

Cognitive theories of learning frame this study's understanding of teaching practices that better improve student learning. In the widely cited consensus report on cognitive theories of learning, Bransford, Brown, and Cocking (2000) distinguish expert from novice learners through experts' knowledge being organized around deep, meaningful understanding. This theoretical framework suggests that deep learning approaches such as reflective and integrative learning strategies, where students critically consider ideas, make connections between ideas, and combine ideas from different sources – and thus are developing deep, meaningful knowledge – are well-suited to promoting long-term knowledge building and the development of expertise. Additionally, learning with understanding is a key in initial learning settings that helps to promote learners' ability to transfer knowledge to future contexts (Bransford et al., 2000; Day & Goldstone, 2012). The use of deep learning, then, not only strengthens the development of knowledge, but student engagement at that level better prepares learners to recall and draw on those meaningful knowledge structures in the future.

A follow-up consensus report to Bransford, et al. (2000) elaborates on teaching strategies that cognitive theories of learning suggest help promote deep learning. The strategies suggested, such as increasing types of student practice, students summarizing or drawing, and developing explanation, all clearly require that students are active participants in their learning (NASEM, 2018). In addition to linking teaching practices that focus on active, student-centered environments to deep and meaningful learning, this theoretical framework suggests that teacher-centered teaching practices will not promote deep and meaningful learning to the same extent.

Culturally Engaging Campus Environments

Another framework guiding this study is the Culturally Engaging Campus Environments (CECE) model (Museus, 2014). The CECE model emphasizes the role that the campus environment plays in student success while considering diverse student population experiences. The model outlines how external and pre-college inputs factor into individuals' influences and success. Museus (2014) posits that a more culturally engaging campus environment at postsecondary institutions can lead to greater student success for diverse student populations. Within the model, there are nine CECE indicators that are examined to illuminate elements of a culturally engaging environment. For the purpose of this particular study, two indicators are highlighted to frame our understanding of this work: culturally relevant knowledge and culturally validating environments. Culturally relevant knowledge suggests that institutions should provide opportunities for students to create and receive knowledge that draws connections back to their home communities by having spaces that allow them to gain better understanding of their communities. Similarly, culturally validating environments suggests that students may have better educational outcomes if they are engulfed in an environment that continually validates their identities and experiences.

These two CECE indicators, culturally relevant knowledge and culturally validating environments, provide another way to understand the potential impact of deep learning on student learning. The development of culturally relevant knowledge inherently requires students to engage in more meaningful ways as they build and develop their knowledge. Drawing connections to their personal communities offers students an opportunity to reflect on their personal experiences and integrate those meaningful understandings into their learning. Faculty providing and facilitating such opportunities for students in their courses and classrooms is one means of creating culturally validating environments. While students' identities and experiences can be validated in other ways within the classroom or outside of it, faculty facilitating those connections between students' own lives and the learning at hand offers a potentially potent way to improve student learning.

Literature Review

Encouragement for faculty to implement effective teaching practices, such as deep approaches to learning, is widespread enough, that a decade ago Nelson Laird, Shoup, Kuh, and Schwarz (2008) noted that faculty in all disciplines are likely to find a colleague emphasizing these approaches in their classrooms. First described by Marton and Säljö (1976), deep-processing was contrasted against surface-level processing wherein students respond in a rote way to learning. Faculty who emphasize deep learning in their courses aim for students to more meaningfully understand course content, for instance by reflecting on new information, students' or others' ideas and integrating these ideas with students' own prior knowledge (Nelson Laird et al., 2008). More recently in an extensive review of research on teaching behaviors, Mayhew et al., (2016) found that good teaching practices include, among others, a "faculty member's ability to design courses…that ask students to think critically about discipline-specific, course-related material," and that faculty "offer opportunities for students to reflect meaningfully on materials presented in class" (p. 133).

Reflective and integrative learning can be seen as one way to incorporate more deep approaches to learning in the classroom. Reflective and integrative learning (RI) consists of faculty providing students with opportunities to connect learning to issues beyond the classroom and reexamine their beliefs while understanding other students' perspectives (BrckaLorenz & Nelson Laird, 2017). Faculty incorporating reflective and integrative learning in their classrooms can help students deeply engage by creating space where each student can connect their personal experiences and beliefs to the material. Cultivation of space where students are open to engage more meaningfully in their classrooms can lead them to engage in more deep approaches to learning, which is related to increases in personal and intellectual development (Nelson Laird, Shoup, & Kuh, 2005).

Tying reflective and integrative learning into STEM classrooms, this pedagogical tool may be a piece of the puzzle needed to foster inclusive environments. The STEM environment continues to be a space that reflects and values the interests of the dominant culture (Nasir & Vakil, 2017), which contributes to the "chilly" climate experienced by minority groups. If STEM faculty find ways to implement reflective and integrative learning strategies into their classrooms, we may be able to see a decrease in the "chilly" climate because more students can view their thoughts and experiences as valid in STEM conversations. However, faculty must buy-in to the possibilities that cultural relevance is tied to STEM content (Fairweather, 2008). STEM faculty are shown to incorporate culturally inclusive teaching practices much less than non-STEM faculty (Ribera, Priddie & BrckaLorenz, 2018). This discrepancy becomes more pronounced as we see white faculty, who are the majority in STEM, incorporate these practices far less than faculty of color (Ribera et al., 2018). These findings suggest that a better understanding of approaches that STEM faculty of color implement to continually engage and validate student experiences in the STEM classroom is needed.

With reflective and integrative learning's focus on students' actively connecting their experiences, beliefs, and learning to create deeper understandings, it is worthwhile to consider another effective pedagogical practice, active learning. Chickering and Gamson (1987) describe the need for active learning, noting that students "must talk about [their learning], relate it to past experiences, apply it to their daily lives" and that they "must make what they learn part of themselves," (p. 4). Notably, this view of active learning relates to reflective and integrative learning in how students bridge their own views and experiences with what they learn. Perhaps unsurprisingly, then, research has shown that faculty emphasis on active and collaborative learning relates positively to students' academic challenge and other areas of students' engagement (Kuh, Nelson Laird, & Umbach, 2004; Umbach & Wawrzynski, 2004). Additionally, Lumpkin, Achen, and Dodd (2015) examined how students perceived their learning following active learning activities, concluding that when students "reflect upon, write about, and then discuss what they are learning, it clarifies their thinking and deepens their understanding and retention," (p. 129). Focusing on active learning in STEM disciplines, Freeman et al. (2014) conducted a meta-analysis of 225 studies which examined active learning versus traditional lecturing in STEM courses. Their results indicate that even though amount and implementation of active learning in these studies varied considerably, students had lower course failure rates and higher exam scores with active learning compared to traditional lecture.

Purpose

This body of research has established the positive benefits of student engagement in deep learning and active, student-centered environments, as well as the important role faculty play in developing such environments and employing teaching practices that offer students opportunities to more deeply engage in learning, particularly in STEM disciplines. We know that faculty identity characteristics, relate to or shape teaching practices (Nelson Laird, Lambert, Cogswell, & Ribera, 2014; Umbach & Wawrzynski, 2004). Given research that identifies significant disciplinary variation in faculty emphasis of deep learning (Nelson Laird et al., 2008), examining how faculty of colors' attitudes and practices vary across disciplines is also crucial to understanding their use of effective teaching practices, such as active learning and reflective and integrative learning. This study seeks to reimagine the research on differences in teaching practices by centering the experiences of faculty of color to better understand how faculty of color approach active and deep learning in different disciplines. In pursuing these goals, this study proposes the following research questions:

1. How does the level of importance faculty of colors place on reflective and integrative learning relate to their usage of active learning?
2. How does the relationship between reflective and integrative learning and the usage of active learning vary across disciplines for faculty of color?

Methods

Data

The data from this study come from the 2014-2019 administrations of the Faculty Survey of Student Engagement (FSSE). FSSE, a complementary survey to the National Survey of Student Engagement for undergraduates at four-year institutions, asks faculty about their use of educational practices that are empirically linked with learning and development. If an institution participated in more than one year of FSSE in the 2014-2019 time period, we only included their most recent year of data in this study resulting in responses from 62,294 faculty from 442 four-year colleges and universities across the United States and Canada. Limiting our data to include faculty with responses to our primary variables of interest resulted in 9,866 faculty respondents from 432 institutions for use in our study.

Measures

One of the primary measures of interest in this study, and the dependent variable in all statistical models, is the FSSE Scale *Reflective & Integrative Learning* (*RI*). This scale is an average composite of seven items measuring how important it is to faculty that the typical student in their courses participates in activities such as understanding something from someone else’s point of view and including diverse perspectives in course discussions or assignments. The primary independent variable of interest is the approximate proportion of time faculty spend on active learning activities during class. Faculty indicated on an ordinal scale their usage of eight types of classroom activities, including both active, student-centered, activities (e.g. small group discussion) and teacher-centered activities (e.g. lecture). These were converted to estimated percentages using the midpoints of each scale point (e.g., 14.5% for a response of 10-19%). Since the sum of these eight estimated percentages was not always 100%, a proportion of the five active learning activities to all eight activities was calculated for comparability across all faculty. See Table 1 for the complete wording of *RI* component items, active learning component items, and general descriptives. Because faculty select one course they are teaching or have taught during the current school year when responding to FSSE, we included additional controls for faculty and course characteristics: faculty gender identity, tenure status, and years of teaching experience; course size, course division (upper- or lower-division), and whether the course meets a general education requirement. See Table 2 for respondent and course descriptives.

Faculty discipline and racial/ethnic identification were other important measures for this study. FSSE asks faculty to write-in a response for "*What is the general academic discipline of your appointment?*" Commonly written disciplines are automatically coded into one of 138 codes used in this study. If the faculty response is not automatically coded, faculty are then asked to choose from the list of 138 disciplines. FSSE additionally asks faculty to select all that apply to the prompt "*What is your racial or ethnic identification?*" Response options include *American Indian or Alaska Native*, *Asian*, *Black or African American*, *Hispanic or Latina/o*, *Middle Eastern or North African* (2019 only), *Native Hawaiian or other Pacific Islander*, *White*, *Another racial or ethnic identification*, and *I prefer not to respond*. Because of our focus on faculty of color, we recoded faculty into five groups: *Asian*, *Black or African American*, *Hispanic or Latina/o*, *Multiracial* (this includes faculty who indicated more than one racial/ethnic identification), and *Another identification* (this includes faculty who indicated *American Indian or Alaska Native*, *Middle Eastern or North African*, *Native Hawaiian or other Pacific Islander*, and *Another racial or ethnic identification*). Despite its limitations, due to low response numbers from the constituent identities, the combination of multiple identities into *Another identity* served as a means to include these faculty voices.

Analysis

To answer our first research question about the relationship between faculty members of colors' attitudes toward the importance of reflective and integrative learning usage of class time, we analyzed multilevel random-slope models, with faculty members' disciplines as the level 2 grouping variable. To better center the experiences of faculty of color, we examined five different groups as defined above (Asian, Black or African American, Hispanic or Latina/o faculty, Multiracial, and Another identification) as separate multilevel models. See Table 3 for descriptives of model sample sizes. A potential limitation of this nesting structure is that FSSE survey data are collected in a stratified way, with faculty samples collected within institutions. However, this nesting structure may better account for variation among faculty given known differences exist across disciplines in faculty teaching (Nelson Laird et al., 2008). Additionally, intraclass correlation coefficients (ICC) indicate that substantially greater variation is accounted for with disciplines as the level 2 grouping variable, than with institutions as the level 2 grouping variable (see Table 4). Despite its limitations, examining faculty teaching views and practices with disciplines as the level 2 grouping variable offers potentially more valuable contributions to extant research. The ICCs using discipline as the level 2 grouping variable provide additional support for using multilevel models.

Since the proportion of active learning used in faculty members' courses is unlikely to be constant across disciplines, to address the second research question, it was entered into the models as a random slope to better understand whether and how teaching practices vary across different disciplines. To evaluate whether the variation across disciplines was significant for each model, chi-square likelihood ratio tests (LRT) were conducted comparing the full models without the random slope to those with the random slope, with significance assessed using a chi-bar distribution[1] (Snijders & Bosker, 2012). Where models showed statistically significant variation across disciplines, general tendencies and the distributions of the model-based empirical Bayes estimates were considered to more fully address the second research question. A

[1] For each model, as only one random slope was added, df=2 for the chi-square LRTs. The chi-bar distribution averages the critical values *df* and *df+1* – for this study, at α=.05 χ_{crit}=7.05, α=.01 χ_{crit}=10.50, α=.001 χ_{crit}=15.36.

limitation of considering empirical Bayes estimates is that since each discipline is not separately and directly modeled by the analysis (for instance by directly entering disciplines as variables in a standard fixed-effect OLS regression model), caution should be used in interpreting the empirical Bayes estimates beyond general trends. However, as examining over 120 disciplines in such a regression model would likely prove impractical, the use of multilevel models and empirical Bayes estimates offers a unique perspective to considering disciplinary differences.

In each full model, our dependent variable *RI* and our primary independent variable of interest, the proportion of active learning activities, were entered as standardized Z-scores so that interpretation of model estimates function as effect sizes and are in relation to the average faculty member. The final random slope model equation, including the individual and course characteristic control variables, used for each of the five model follows:

$$\boldsymbol{RI}_{ij} = \gamma_{00} + \gamma_{1j}(\boldsymbol{Est.proportion\ of\ active\ activity})_{ij} + \gamma_{20}(Woman)_{ij} + \gamma_{30}(Tenured)_{ij} + \gamma_{40}(Years\ of\ teaching)_{ij} + \gamma_{50}(Gen\ ed\ course)_{ij} + \gamma_{60}(Upper\ division\ course)_{ij} + \gamma_{70}(Other\ division\ course)_{ij} + \gamma_{80}(Small\ course)_{ij} + \gamma_{90}(Medium\ course)_{ij} + U_{0j} + R_{ij}$$

Results

How does the level of importance faculty of colors place on reflective and integrative learning relate to their usage of active learning?

Controlling for individual and course characteristics, and accounting for faculty disciplines, the proportion of active learning activities in class was positively and significantly associated with the importance faculty place on *Reflective & Integrative Learning* for all groups of faculty of color. See Table 5 for full model details.

As seen in Table 5, among Asian faculty, holding all variables constant, the model intercept suggests that a faculty member whose class has an average proportion of active learning would be expected place less importance on *RI* (-0.2) than a typical faculty member. For Asian faculty, a one standard deviation increase in the proportion of active learning, holding all else constant, would be expected to result in a 0.23 standard-deviation increase in the importance Asian faculty members place on *RI*. Black or African American faculty members whose classes use the average proportion of active learning place more importance on *RI* (0.3), while Hispanic or Latino/a faculty (-0.05) and faculty of another identity (-0.03) place slightly less importance on *RI* relative to the overall average faculty member of color. For Black or African American faculty, Hispanic or Latino/a faculty, or faculty of another identity, this relationship, all else being equal, results in a 0.17 increase in *RI* importance. Multiracial faculty whose classes use an average proportion of active learning place less importance on *RI* (-0.24), and the increase in *RI* importance for each standard-deviation increase in the proportional of active learning is expected to be 0.13.

How does the relationship between reflective and integrative learning and the usage of active learning vary across disciplines for faculty of color?

The random slope models also allow us to consider whether and how the relationship between *RI* importance and the proportion of class time spent on active learning varies for different disciplines among faculty of color, since these models do not assume that faculty in all disciplines utilize active learning in the same way. It is necessary, then, to first consider what the models indicate the variability is in the relationship between *RI* importance and active learning (i.e. the slope) for each faculty of color group, and whether that variability is significantly different from zero (see Table 5). Among Asian faculty, the variance in the slopes for the distribution of disciplines (0.008) was not significantly different from zero (χ^2=1.4, df=2, p>.05). Similarly, among multiracial faculty the variance in the slopes (0.017) was not significant (χ^2=6.7, df=2, p>.05). The variance in the *RI*-active learning slopes for disciplines of Black or

African American faculty (0.027) was significant (χ^2=16.6, df=2, p<.001), as were the variances for the slopes for Hispanic or Latino/a faculty (0.009, χ^2=9.9, df=2, p<.05) and faculty of another identity (0.054, χ^2=22.5, df=2, p<.001). These results indicate that the relationship between *RI* importance and the proportion of active learning in courses does vary across disciplines among Black or African American, Hispanic or Latino/a, and faculty of another identity, while it does not vary across disciplines among Asian and multiracial faculty.

With the relationship between *RI* importance and the proportion of active learning varying across disciplines among Black or African American, Hispanic or Latino/a, and faculty of another identity, it is important to consider how it varies. Across all three faculty of color groups, holding all individual and course characteristics constant, the covariance between the importance faculty place on *RI* and the proportion of active learning in their courses is negative (Table 5). This indicates that as these faculty of color increase their use of active learning, disciplinary variation in *RI* importance tends to decrease. Generally, this means that in disciplines where the average faculty member of color places a lower level of importance on *RI*, increasing the proportion of active learning tends to relate to greater increases in how they view the importance of *RI*; whereas, in disciplines where the average faculty member already places a higher level of importance on *RI*, increasing the proportion of active learning in their courses either tends to relate to little change in their views of *RI* or relates to slight decreases in their views of the importance of *RI*. This narrowing of disciplinary differences as the proportion of active learning increases is most pronounced among Hispanic or Latino/a faculty, where the covariance is -1.0. The covariance for Black or African American faculty is -0.5, while for faculty of another identity is -0.6.

Figures 1 to 3 depict how these relationships between the importance faculty of color place on *RI* and their use of active learning differ and vary across disciplines, by plotting a sample of the discipline-specific regression lines for active learning on *RI* importance. These plots use the empirical Bayes estimated coefficients, which add the overall model-estimated fixed effects (see the "Fixed Effects" section of Table 5) to the discipline-specific random effect term estimates for each discipline (which account for the degree to which each discipline differs from the overall model intercept or overall model slope for proportion of active learning). As not all disciplines are equally represented within each faculty of color group, the empirical Bayes estimates weight the observed discipline-group means with the model-estimated overall means, providing conservative, but more precise estimations across all disciplines. As there are 120 or more disciplines represented across each of the three faculty of color groups, each plot display a selection of STEM and non-STEM disciplines (approximately one-fifth of all disciplines).

With the focus on STEM disciplines and disciplinary differences, it is worthwhile to explore general trends in the empirical Bayes estimates of the discipline-specific random effects terms for Black or African American, Hispanic or Latino/a, and faculty of another identity. Tables 6 and 7 summarize the distributions of the empirical Bayes-estimated random intercepts (*RI* importance) and random slope (proportion of active learning) terms for STEM and non-STEM disciplines for each model. Looking at the distributions of random intercept terms, the median and mean intercept terms for STEM disciplines are lower than those of non-STEM disciplines; however, substantial overlap between the two distributions is clear. The distributions of random slope terms, again indicating how the proportion of active learning among faculty in each discipline relates to the importance of *RI* in their courses, show substantial similarities between STEM and non-STEM differences among these three faculty groups. The overlaps between STEM and non-STEM disciplines are evident looking at Figures 1 to 3.

Discussion and Implications

With the increasing attention on increasing the cultural relevance and inclusiveness of faculty members' pedagogical practices in STEM disciplines, this study sought to better understand the relationship between pedagogical practices and views of faculty of color across diverse disciplines by using multilevel models. Specifically, the first research question considered the relationships between faculty of colors' views of reflective and integrative learning – an aspect of deep learning – and their usage of active learning in their classrooms. Within the framework of cognitive theories of learning, the results on this first questions, while significant, were perhaps unsurprising. Controlling for individual and course characteristics, for Asian, Black or African American, Hispanic or Latino/a, multiracial, and faculty of another identity, the proportion of active learning used was significantly and positively associated with faculty placing higher importance on reflective and integrative learning in their courses. The pedagogical views and practices of faculty of color, then, are generally well-aligned with cognitive theories of learning which suggest that as students more actively engage, and engage more deeply, their learning will improve, as will their ability to recall and draw on their knowledge in the future. These results also broadly agree with research on active learning that suggested positive relationships with reflective and integrative learning (Lumpkin, Achen, & Dodd, 2015; Umbach & Wawrzynski, 2004). While these results align well with research and theory, centering faculty of colors' views and practices contributes a valuable perspective to this body of research.

The CECE framework – specifically the two indicators, culturally relevant knowledge and culturally validating environments – provides an even more nuanced understanding of these results, as reflective and integrative learning offers one way students can make meaningful connections between their lived experiences and their learning. The more reflective and integrative learning students engage in, the better – potentially – they can develop more culturally relevant knowledge. With active learning positively associated with increases in the importance faculty of color place on reflective and integrative learning, active learning could be a valuable culturally relevant and inclusive set of pedagogical practices. As with any pedagogical practice, faculty professional development that helps faculty use active learning and reflective and integrative learning to create culturally validating environments could prove valuable.

The second research question extended on these results by considering whether and how the relationship between active learning usage and faculty of colors' views on the importance of reflective and integrative learning varied across disciplines. Notably for Asian and multiracial faculty, the variance across disciplines in the relationship between *RI* importance and faculty use of active learning was not significant, that for these faculty of color, there is no evidence that the relationship between these faculty views and practices differ systematically across disciplines. For Black or African American, Hispanic or Latino/a, and faculty of another identity, there was a significant difference across disciplines, suggesting that future research into why these differences exist and their causes would be a valuable contribution to researchers' and faculty members' understandings of how to improve their teaching, particularly in culturally more relevant and inclusive ways. For these three faculty of color groups, the covariances indicated that as the proportion of active learning in the classroom increases, differences between disciplines in the importance faculty place on reflective and integrative learning in their courses decrease. For Hispanic or Latino/a faculty, this effect was considerable, with increases in active learning substantially minimizing differences between disciplines in how importantly they view reflective and integrative learning.

In broad terms for Black or African American, Hispanic or Latino/a, and faculty of another identity, these findings suggest that increased active learning helps to level the playing field across disciplines in how faculty view reflective and integrative learning. In disciplines where faculty of color tend to place low importance on reflective and integrative learning, faculty of color who make efforts to maximize active learning in their classrooms are more likely to place outsized importance on reflective and integrative learning. Oppositely, faculty of color in disciplines that tend to already place higher levels of importance on reflective and integrative learning may or may not place any greater importance on it, the more active learning they use (and they may even tend to place less importance on reflective and integrative learning). For these latter disciplines among faculty of color, this could reflect a ceiling effect – if reflective and integrative learning is already viewed as important in those disciplines, the chances of any pedagogical practice being related to views of its increased importance are smaller.

The empirical Bayes estimates for each model allow us to more clearly consider how STEM faculty of color view reflective and integrative learning relative to their usage of active learning, since they estimate how faculty of each discipline differ from the overall faculty samples. Since research tends to focus on differences between STEM and non-STEM disciplines, it is useful to consider this framing in examining the discipline-specific estimates. Notably, this study suggests that differences between STEM and non-STEM disciplines are small. While, for

Black or African American, Hispanic or Latino/a, and faculty of another identity, STEM disciplines tended to place slightly less importance on reflective and integrative learning compared to non-STEM disciplines, there was considerable overlap in those two distributions of disciplines – some STEM disciplines placed higher importance and some non-STEM disciplines placed lower importance on reflective and integrative learning. Additionally, STEM disciplines tended to have slightly more positive relationships between increasing active learning use and the importance of reflective and integrative learning, so as active learning increased the overlap between STEM and non-STEM disciplines in reflective and integrative learning views appeared to slightly increase.

These findings suggest that for considering disciplinary differences, at least for some faculty of color, a STEM/non-STEM dichotomy potentially obscures more nuanced understandings of pedagogical views and practices. This dichotomy in research risks erasing positive experiences and accomplishments of faculty in some STEM disciplines while also erasing potential areas of concern in non-STEM disciplines. For faculty and faculty developers, this research suggests that models of these effective teaching practices exist in some STEM disciplines, potentially in life science disciplines, but also that active learning could be particularly impactful in other STEM disciplines, such as engineering and computer sciences.

Conclusion

While faculty, administrators, and researchers increasingly focus on improving and developing faculty teaching, this goal has taken even greater importance in STEM disciplines, where some hope to address problems with minority representation by improving the cultural relevance and inclusivity of their courses (Dewsbury, 2017). Noting that active learning and reflective and integrative learning are effective pedagogical practices that could potentially allow students to create more meaningful and culturally relevant understandings of their learning, this study sought to reimagine research in teaching practices across disciplines by centering the views and practices of faculty of color. This study adds to the literature on active and deep learning, confirming that for Asian, Black or African American, Hispanic or Latino/a, multiracial, and faculty of another identity, increasing the amount of active learning in courses related to modest increases in the importance faculty place on reflective and integrative learning in their courses. Though further study would be needed, this suggests that faculty could potentially create more culturally relevant and inclusive classroom environments for diverse students through the use of reflective and integrative active learning activities.

This study also offers evidence that significant disciplinary differences exist in how active learning usage relates to the importance Black or African American, Hispanic or Latino/a, and faculty of another identity place on reflective and integrative learning. Furthermore, deep learning in STEM and non-STEM disciplines may not be as different as is sometimes thought, and that other disciplinary distinctions may be more useful in targeting opportunities for pedagogical improvement. Lastly, this study indicates that while overall active learning is positively associated with increased faculty views of reflective and integrative learning, this effect is most pronounced in disciplines with less emphasis on reflective and integrative learning. With the conceptual links between active learning, reflective and integrative learning, and the development of culturally relevant knowledge and environments, faculty, administrators, and researchers have reason to be encouraged about improving cultural relevance and inclusion in STEM disciplines.

References

Beach, A. L., Henderson, C., & Finkelstein, N. (2012). Facilitating change in undergraduate STEM education. *Change: The Magazine of Higher Learning*, *44*(6), 52-59.

Bransford, J.D., Brown, A.L., & Cocking, R.R. (Eds.). (2000). *How people learn: Brain, mind, experience, and school*. Washington, D.C.: National Academy Press.

BrckaLorenz, A., & Nelson Laird, T. (2017). *Reflective & Integrative Learning*. Faculty Survey of Student Engagement.

Chickering, A. W., & Gamson, Z. F. (1987). Seven principles of good practice in undergraduate education. *AAHE Bulletin*, 39 (7), 3–7.

Day, S.B. & Goldstone, R.L. (2012). The import of knowledge export: Connecting findings and theories of transfer of learning. *Educational Psychologist*, *47* (3), 153-176.

Dewsbury, B. M. (2017). On faculty development of STEM inclusive teaching practices. *FEMS microbiology letters*, *364*(18).

Fairweather, J. (2008). Linking evidence and promising practices in science, technology, engineering, and mathematics (STEM) undergraduate education. *Board of Science Education, National Research Council, The National Academies, Washington, DC*.

Freeman, S., Eddy, S.L., McDonough, M., Smith, M.K., Okoroafor, N., Jordt, H., & Wenderoth, M.P. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences USA 111, 8410-8415.

Griffin, K. A., Perez, D., Holmes, A. P., & Mayo, C. E. (2010). Investing in the future: The importance of faculty mentoring in the development of students of color in STEM. *New Directions for Institutional Research*, *2010*(148), 95-103.

Haynes, C., & Patton, L. D. (2019). From Racial Resistance to Racial Consciousness: Engaging White STEM Faculty in Pedagogical Transformation. *Journal of Cases in Educational Leadership*, *22*(2), 85-98.

Hurtado, S., Newman, C. B., Tran, M. C., & Chang, M. J. (2010). Improving the rate of success for underrepresented racial minorities in STEM fields: Insights from a national project. *New Directions for Institutional Research*, *2010* (148), 5-15.

Jett, C. C. (2013). Culturally responsive collegiate mathematics education: Implications for African American students. *Interdisciplinary Journal of Teaching and Learning*, *3*(2), 102-116.

Johnson, A., Ong, M., Ko, L. T., Smith, J., & Hodari, A. (2017). Common Challenges Faced by Women of Color in Physics, and Actions Faculty Can Take to Minimize Those Challenges. The Physics Teacher, 55(6), 356-360.

Kuh, G.D., Nelson Laird, T.F., & Umbach, P.D. (2004). Aligning faculty activities and student behavior: Realizing the promise of Greater Expectations. *Liberal Education*, 90 (4), 24-31.

Lumpkin, A., Achen, R.M., & Dodd, R.K. (2015). Student perceptions of active learning. *College Student Journal*, 49 (1), 121-133.

Marton, F., & Säljö, R. (1976). On qualitative differences in learning I: Outcome and process. *British Journal of Educational Psychology*, 46, 4–11.

Mayhew, M. J., Rockenbach, A. N., Bowman, N. A., Seifert, T. A., Wolniak, G. C., Pascarella, E. T., & Terenzini, P. T. (2016). *How college affects students: 21st century evidence that higher education works.* San Francisco, CA: Jossey-Bass.

Moriarty, M. A. (2007). Inclusive pedagogy: Teaching methodologies to reach diverse learners in science instruction. *Equity & Excellence in Education*, *40*(3), 252-265.

Museus, S. D. (2014). The culturally engaging campus environments (CECE) model: A new theory of success among racially diverse college student populations. In *Higher education: Handbook of theory and research* (pp. 189-227). Springer, Dordrecht.

Nasir, N.S. & Vakil, S. (2017). STEM-focused academies in urban schools: Tensions and possibilities. *Journal of the Learning Sciences*, 26 (3), 376-406. DOI: 10.1080/10508406.2017.1314215

National Academies of Sciences, Engineering, and Medicine [NASEM]. (2018). How People Learn II: Learners, Contexts, and Cultures. Washington, DC: The National Academies Press. doi: https://doi.org/10.17226/24783.

Nelson Laird, T., Lambert, A., Cogswell, C.A., & Ribera, A. (2014). Faculty still matter to student engagement! Presentation at the *Association for Institutional Research Annual Forum*, Orlando, FL.

Nelson Laird, T. F., Kuh, G. D., & Shoup, T. R. (2005). Deep learning and college outcomes: Do fields of study differ? Presentation at the *Association for Institutional Research Annual Forum*, San Diego, CA.

Nelson Laird, T.F., Shoup, R., Kuh, G.D., & Schwarz, M.J. (2008). The effects of discipline on deep approaches to student learning and college outcomes. *Research in Higher Education*, 49, 469-494.

Ribera, A., Priddie, C., & BrckaLorenz, A. (2018, November). The time is now: A study promoting STEM faculty use of culturally inclusive teaching. Paper presented at the *Association for the Study of Higher Education Annual Conference*, Tampa, FL.

Salazar, M. D. C., Norton, A. S., & Tuitt, F. A. (2010). 12: Weaving promising practices for inclusive excellence into the higher education classroom. *To improve the academy*, *28*(1), 208-226.

Snijders, T.A.B. & Bosker, R.J. (2012).Multilevel analysis: An introduction to basic and advanced multilevel modeling (2nded.). Los Angeles, CA: Sage.

Umbach, P.D. & Warzynski, M.R. (2004). Faculty do matter: The role of college faculty in student learning and engagement. Paper presented at the *Association for Institutional Research Annual Forum*, Boston, MA.

Appendix: Tables and Figures

Table 1. Aggregate Measure Component Items and Descriptives

Aggregate Measure	Component Items	Descriptives
Reflective & Integrative Learning	**In your selected course section, how important is it to you that the typical student do the following?** *Response options: Very important, Important, Somewhat important, Not important* a. Combine ideas from difference courses when completing assignments b. Connect their learning to societal problems or issues c. Include diverse perspectives (political, religious, racial/ethnic, gender, etc.) in course discussions d. Examine the strengths and weaknesses of their own views on a topic or issue e. Try to better understand someone else's views by imagining how an issue looks from their perspective f. Learn something that changes the way they understand an issue or concept g. Connect ideas from your course to their prior experiences and knowledge	Minimum = 0 Maximum = 60 Average = 44.56 Std. Dev. = 13.597 Cronbach's α = .881 ICC = .039
Active Learning	**In your selected course section, about what percent of class time is spent on the following?** *Response options: 0%, 1-9%, 10-19%, 20-29%, 30-39%, 40-49%, 50-74%, 75% or more* a. Discussion b. Small-group activities c. Student presentations or performances d. Independent student work (writing, painting, designing, etc.) e. Experiential activities (labs, field work, clinical or field placements, etc.)	Minimum = 0 Maximum = 1.00 Average = .55 Std. Dev. = .23

Table 2. Respondent and Course Characteristics and Model Coding Details

		Asian (%)	Black or African American (%)	Hispanic or Latino/a (%)	Multiracial (%)	Another identity (%)	Model Coding Details
Disciplinary Area	Arts & Humanities	12.3	14.3	27.7	26.8	21.6	These eleven groupings represent categories of the 138 individual disciplines used in level 2 of models.
	Bio. Sci., Agric., & Nat. Resources	7.3	4.8	5.8	7.6	6.2	
	Phys. Sci., Math., & CS	19.9	8.5	8.2	9.1	9.4	
	Social Sciences	9.7	13.4	12.1	14.7	15.6	
	Business	15.6	9.7	7.4	6.1	9.9	
	Comm., Media, & PR	2.1	4.1	2.9	3.5	3.4	
	Education	4.8	11.9	12.3	8.9	9.0	
	Engineering	14.1	4.1	3.6	4.1	4.9	
	Health Professions	6.4	12.1	9.0	8.5	8.8	
	Social Service Professions	2.0	8.0	4.1	4.1	4.0	
	Other disciplines	5.7	9.1	7.0	6.6	7.3	
Gender Identity	Man	58.4	43.1	47.8	43.3	48.5	Dichotomized, Woman = 1, else = 0
	Woman	40.5	56.3	50.1	53.2	45.1	
	Another gender identity	0.0	0.1	0.3	1.1	1.2	
	I prefer not to respond	1.1	0.5	1.9	2.4	5.2	
Tenure Status	No tenure system at this institution	9.1	13.8	13.1	12.6	15.2	Dichotomized, Tenured = 1, else = 0
	Not on tenure track, but this institution has a tenure system	22.2	37.8	36.7	35.1	30.8	
	On tenure track but not tenured	27.7	18.4	18.8	21.7	14.8	
	Tenured	41.0	30.0	31.4	30.6	39.2	
Years of Teaching Experience	4 or less	22.3	18.5	19.6	20.9	13.0	Continuous
	5-9	20.9	19.7	18.2	19.0	17.9	
	10-19	30.4	31.2	33.0	33.6	32.2	
	20-29	16.0	18.7	18.5	17.2	19.6	
	30 or more	10.3	11.9	10.6	9.3	17.3	
Course Size	20 or fewer	26.7	32.4	35.2	33.8	31.8	Dummy variables, 20 or fewer = Small, 21-30 = Medium, else = Reference
	21-30	30.4	33.3	33.5	34.1	30.1	
	31-40	18.8	14.5	13.8	13.5	15.9	
	41-50	8.0	6.4	6.6	7.2	7.9	
	51-100	10.7	9.6	7.0	7.6	10.3	
	More than 100	5.3	3.8	4.0	3.8	4.0	
Course Division	Lower division (mostly first-year students or sophomores)	33.5	39.3	42.5	38.2	35.7	Dummy variables, Lower = Reference, Upper division = Upper, Other = Other
	Upper division (mostly juniors or seniors)	60.1	51.7	50.9	53.7	54.8	
	Other	6.4	9.0	6.6	8.1	9.5	
Gen. Ed. Requirement	No	38.3	40.8	37.5	47.7	43.8	Dichotomized, Yes = 1, else = 0
	Yes	61.7	59.2	62.5	52.3	56.2	

Table 3. Model sample sizes

	Model 1 Asian	Model 2 Black or African American	Model 3 Hispanic or Latina/o	Model 4 Multiracial	Model 5 Another Identity
Faculty members (Level 1)	2,672	2,824	1,760	1,483	1,127
Faculty disciplines (Level 2)	129	129	126	124	121
Minimum discipline group size	1	1	1	1	1
Maximum discipline group size	163	139	151	85	47
Mean discipline group size	20.5	21.7	13.8	11.9	9.2

Table 4. Unconditional model variation and ICC

	Model 1 Asian	Model 2 Black or African American	Model 3 Hispanic or Latina/o	Model 4 Multiracial	Model 5 Another Identity
Disciplines as Level 2					
$\tau 2$	0.162	0.086	0.144	0.247	0.150
$\sigma 2$	0.870	0.571	0.657	0.656	0.708
ICC	0.157	0.130	0.180	0.274	0.175
Institutions as Level 2					
$\tau 2$	0.041	0.005	0.040	0.014	0.004
$\sigma 2$	1.015	0.675	0.733	0.835	0.904
ICC	0.038	0.009	0.052	0.016	0.005

Table 5. Fixed and Random Effects Estimates for Faculty Importance of *Reflective & Integrative Learning*

	Model 1 Asian			Model 2 Black or African American			Model 3 Hispanic or Latina/o			Model 4 Multiracial			Model 5 Another Identity		
Proportional reduction in variance (R^2)	9.2%			6.0%			10.9%			13.2%			17.2%		
Random effects	Var.	S.D.	Cov.	Var.	S.D.	Cov.	Var.	S.D.	Cov.	Var.	S.D.	Cov.	Var.	S.D.	Cov.
Discipline (U_{0j})	.11	.34		.07	.27		.10	.32		.17	.41		.08	.28	
Est. Proportion of Active Learning (γ_{1j})	.01	.09	-.12	.03	.16	-.45	.01	.09	-1.00	.02	.13	-.4	.05	.23	-.61
Individual (R_{ij})	.82	.91		.55	.74		.61	.78		.62	.78		.63	.80	
Fixed effects	Est.	S.E.	Sig.	Est.	S.E.	Sig.	Est.	S.E.	Sig.	Est.	S.E.	Sig.	Est.	S.E.	Sig.
Intercept	-.20	.07	**	.30	.06	***	-.05	.08		-.24	.09	**	-.03	.10	
Est. Proportion of Active Learning	.23	.027	***	.17	.029	***	.17	.029	***	.13	.032	***	.17	.044	***
Woman	.09	.044	*	.05	.034		.15	.044	***	.21	.048	***	.20	.057	***
Tenured	-.06	.048		.05	.040		.05	.052		-.01	.059		.02	.063	
Years of Teaching Experience	.00	.002		.00	.002	*	.00	.002		.00	.003		.00	.003	
General Education Course	.18	.043	***	.08	.035	*	.28	.047	***	.25	.051	***	.24	.060	***
Upper Division Course	.19	.047	***	.11	.036	**	.25	.047	***	.31	.054	***	.19	.062	**
Lower Division Course	.33	.085	***	.08	.058		.05	.088		.21	.088	*	.19	.099	
Small Course	-.12	.051	*	-.08	.040		-.08	.055		.00	.061		-.03	.068	
Medium Course	.00	.048		-.02	.039		-.05	.054		.01	.058		.02	.066	

*p<.05, **p<.01, ****p* < .001

Figure 1. Sample of discipline-specific regression lines for active learning on *RI* importance, Black or African American faculty

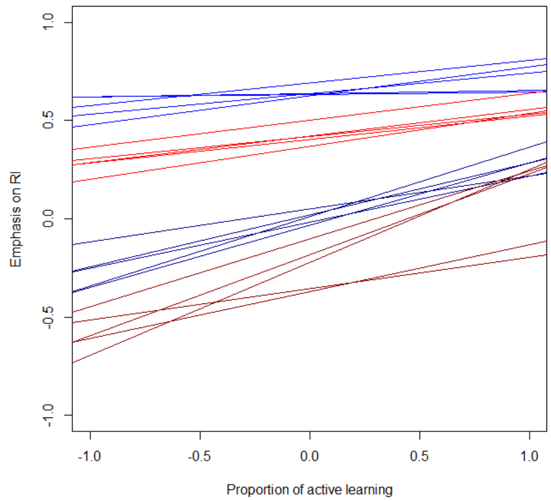


Figure 2. Sample of discipline-specific regression lines for active learning on *RI* importance, Hispanic or Latino/a faculty

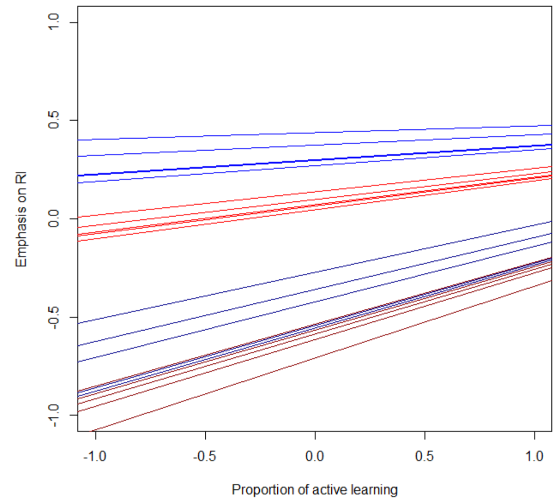
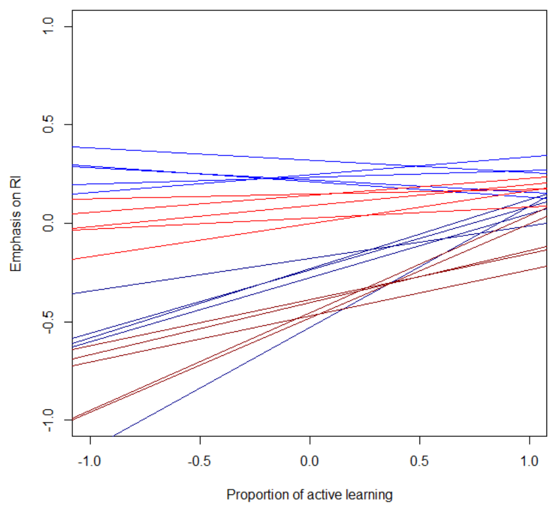


Figure 3. Sample of discipline-specific regression lines for active learning on *RI* importance, faculty of another identity



NOTE: Using the discipline-group intercepts, the five highest STEM (red) and non-STEM (blue) disciplines are depicted, along with the five lowest STEM (dark red) and non-STEM (dark blue) disciplines.

Table 6. Summary of random intercept empirical Bayes estimate distributions

	Model 2 Black or African American		Model 3 Hispanic or Latina/o		Model 5 Another Identity	
	STEM	Non-STEM	STEM	Non-STEM	STEM	Non-STEM
Number of disciplines	34	92	33	88	30	86
Minimum	-0.67	-0.33	-0.66	-0.51	-0.45	-0.50
First Quartile	-0.23	-0.06	-0.39	0.00	-0.31	-0.03
Median	-0.08	0.06	-0.14	0.08	-0.15	0.06
Third Quartile	-0.01	0.16	-0.01	0.19	-0.02	0.14
Maximum	0.20	0.39	0.18	0.48	0.17	0.35
Mean	-0.14	0.05	-0.19	0.07	-0.16	0.05

Table 7. Summary of random slope empirical Bayes estimate distributions

	Model 2 Black or African American		Model 3 Hispanic or Latina/o		Model 5 Another Identity	
	STEM	Non-STEM	STEM	Non-STEM	STEM	Non-STEM
Number of disciplines	34	92	33	88	30	86
Minimum	-0.09	-0.22	-0.05	-0.14	-0.20	-0.24
First Quartile	0.00	-0.07	0.00	-0.06	0.00	-0.08
Median	0.03	-0.01	0.04	-0.02	0.08	-0.03
Third Quartile	0.08	0.03	0.11	0.00	0.15	0.02
Maximum	0.31	0.19	0.19	0.15	0.42	0.45
Mean	0.05	-0.02	0.06	-0.02	0.09	-0.03