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Exploring Department vs. Institution Workplace Satisfaction Alignment Among STEM Instructional Faculty at HSIs using Machine Learning

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Motivations and Background

Faculty play an important role in higher education by preparing the future workforce, advancing knowledge through innovative research, and fostering vibrant scholarly communities [1]. To sustain and strengthen these communities, stakeholders need to understand the supports that enhance faculty satisfaction [2]. Faculty experiences—and thus their satisfaction—are shaped by both departmental interactions (e.g., with chairs, colleagues, and staff) and broader institutional resources (e.g., salary, technological support, and access to proper classroom space). A pressing question is whether satisfaction at the department level aligns with satisfaction at the institutional level, or if discrepancies exist. This study explores this alignment specifically for STEM instructional faculty at Hispanic-Serving Institutions (HSIs).

Literature Review

Although tenure has traditionally been viewed as the gold standard of academic professional success, recent hiring trends indicate a significant shift away from full-time tenured (T) and tenure-track (TT) positions toward Professional Track (PT) appointments, including part-time and full-time faculty who may or may not be eligible for tenure [3]. PT appointments vary widely, and those focused on instruction typically involve heavier teaching responsibilities for lower-division courses than those of their T or TT counterparts [4]. We refer to these faculty members as PT Instructional Faculty, recognizing their significant student contact through teaching. Despite their growing numbers and sharing comparable educational backgrounds, aspirations, and expertise with their T and TT colleagues [5], [6], research on faculty experiences continues to prioritize T and TT faculty, creating substantial gaps in our understanding of the broader professoriate. This perspective fails to acknowledge the unique structural conditions that define the work experiences of instructional faculty, including reliance on term-based contracts, lower compensation, and restricted involvement in shared governance [7], [8].

Faculty satisfaction is multifaceted, encompassing a variety of interconnected factors [9], such as academic freedom, autonomy, work-life balance, effective leadership, equity, collegiality, flexibility, and a sense of respect [6], [10]. Previous studies have examined how these factors mediate faculty well-being [11], investigated the impact of working conditions on commitment [12] and explored how departmental culture impacts faculty performance [13]. However, the relationship between departmental and institutional satisfaction remains understudied. In our literature review, only one study directly compared these two satisfaction domains [14]. In a qualitative study previously conducted by our team [15], we identified a faculty member who reported high departmental satisfaction while simultaneously experiencing institutional barriers at the college level that negatively impacted their promotion process. Notably, in this case, departmental support helped mitigate negative institutional influences. Conversely, another participant in the same study experienced a continuous lack of respect at the departmental level,

ultimately leading to their resignation. Therefore, we propose that alignment between departmental and institutional satisfaction represents an organizational dynamic that merits exploration.

The Context: STEM at Hispanic Serving Institutions

HSIs provide a unique institutional context for understanding instructional faculty experiences. HSIs serve student populations with high percentages of first-generation college students, commuters, and Pell Grant recipients working in environments that differ notably from those at more traditionally resourced, top STEM-producing institutions [16]. Despite comprising only 9% of institutions offering undergraduate engineering programs, HSIs have emerged as strong contributors to engineering education and overall Latiné student success in STEM fields [17], Instructional faculty play a central role in these outcomes through their teaching practices and curricular decisions [18]. While recent studies have begun to document the experiences of STEM instructional faculty at HSIs [19], [20], [21], [22], [23], important gaps remain in our understanding of this population and their perceptions of satisfaction. To address this gap, the current study poses two research questions within the STEM HSI context:

RQ1: Is there alignment in faculty satisfaction between department and institution levels?

RQ2: Can we identify which factors may contribute to the satisfaction differences between these organizational levels?

Methods

Data Source

This study analyzed responses to Harvard's Collaborative on Academic Careers in Higher Education (COACHE) survey, a widely used instrument administered to over 250 U.S. academic institutions since 2005 [24]. The COACHE survey includes 170 Likert-scale items that assess various aspects of faculty experiences and demographics. Our analysis focused on two items measuring level of satisfaction or dissatisfaction. Both items used a 5-point Likert scale, with lower values indicating dissatisfaction and higher values indicating satisfaction.

Department Satisfaction: *"All things considered, your department as a place to work."*
Institutional Satisfaction: *"All things considered, your institution as a place to work."*

Data Limitations

The data used in this survey were collected between 2015 and 2020—a period prior to significant global and higher education changes. This timing represents a key limitation, as faculty experiences and institutional contexts have shifted considerably since then. Additionally, when checking for misalignment, we did not control rank, gender, or institution type—potential confounding variables [25]. Finally, voluntary participation introduces possible self-selection bias, as survey respondents may differ systematically from non-participants, affecting generalizability [26].

Data Cleaning and Sample Selection

We identified STEM instructional faculty across 26 HSIs (99% public and 50% 4-year universities) through a five-step filtering process. We first selected HSI respondents (n=39,578), then filtered for STEM disciplines (n=10,317). To ensure data quality, we excluded responses with >80% identical answers (n=4,605) and removed incomplete responses (n=2,567). Finally, we selected instructional faculty by including all non-tenure track faculty (n=505). We also included tenure-track (n=293) and tenured faculty (n=173) from 2-year HSIs where teaching is typically the primary focus. This process yielded a sample of 834 STEM instructional faculty members at HSIs (see Table 1).

Table 1: Sample Demographics

Demographics	**%**
Race	
White (non-Hispanic)	59.2%
Asian, Asian American, or Pacific Islander	17%
Hispanic or Latino	11%
Black or African American	6.1%
Multiracial	2.6%
Middle Eastern, Southwest Asian, or North African	2.0%
Other	1.5%
American Indian or Native Alaskan	0.3%
Gender	
Man / Trans man	53.7%
Woman / Trans woman	45.7%
Other	0.4%
Transgender	0.2%
Academic Title	
Instructor/Lecturer	40.8%
Assistant Professor	22.8%
Associate Professor	17.3%
Full Professor	15.6%
Unspecified	3.5%
Other	0.1%
Discipline	
Engineering/Computer Science/Math/Statistics	53.5%
Physical Sciences	26.6%
Biological Sciences	15.8%
Interdisciplinary Department/Division - STEM	4.2%

Results

To address our first research question—whether alignment exists between faculty satisfaction at the departmental and institutional levels, we conducted a two-sided Wilcoxon signed-rank test, a non-parametric method appropriate for ordinal Likert-type data [27]. The analysis indicated a statistically significant difference between departmental and institutional satisfaction (Wilcoxon statistic = 12,697.5, $p < 0.001$) with a moderate effect size ($r = 0.266$). As shown in Figure 1, the majority of faculty (n = 567) reported aligned satisfaction levels between their department and institution. However, when misalignment occurred, faculty were more likely to report higher satisfaction with their department (n = 181, values ≥ 1). A smaller proportion reported higher institutional satisfaction (n = 86, values ≤ -1) compared to departmental satisfaction.

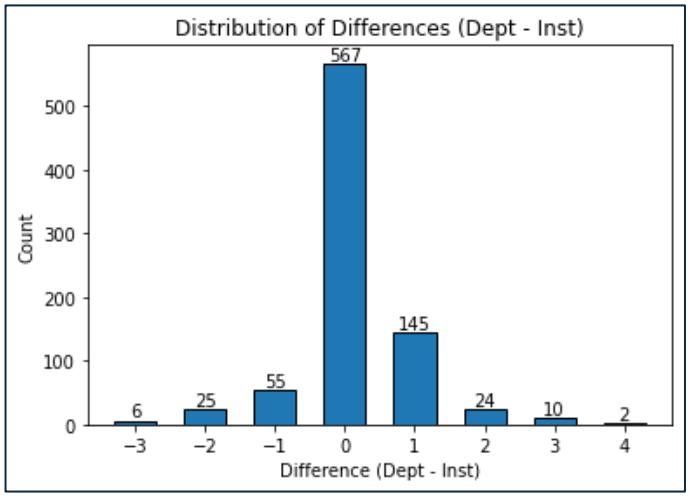

Figure 1: Distribution of differences in departmental vs. institutional satisfaction

To address our second research question—identifying factors contributing to satisfaction differences—faculty were categorized into three classes based on the alignment of their satisfaction ratings: (0) No Difference (alignment), (1) Department-Favored Satisfaction, and (2) Institution-Favored Satisfaction. Given the extensive nature of our dataset (170 items), we narrowed our focus to 81 variables related to departmental factors (e.g., chair support, recognition within department) and institutional factors (e.g., salary, classroom availability, access to equipment) as well as demographic variables (e.g. gender, institution type, rank).

We employed a data-driven approach for feature selection using Recursive Feature Elimination (RFE) [28], a machine learning technique that iteratively removes less informative variables to prioritize those most predictive of the outcome. To implement RFE, we used a CatBoost Classifier—a decision tree-based algorithm known for effectively handling categorical variables and evaluating feature importance [29]. The outcome variable was treated as categorical with three classes previously mentioned, enabling the model to identify patterns associated with all three satisfaction alignment classes. We iterated through feature items and assessed how prediction accuracy changed as features were added. The model identified the top eight most influential features (Figure 2), yielding a classification accuracy of 73%. These features represented a mix of departmental and institutional dimensions, offering initial insights

into the key factors of satisfaction classes. In future work, we aim to further examine the relationships between these features and satisfaction classes, including estimating odds ratios to better quantify their influence and support stronger interpretations.

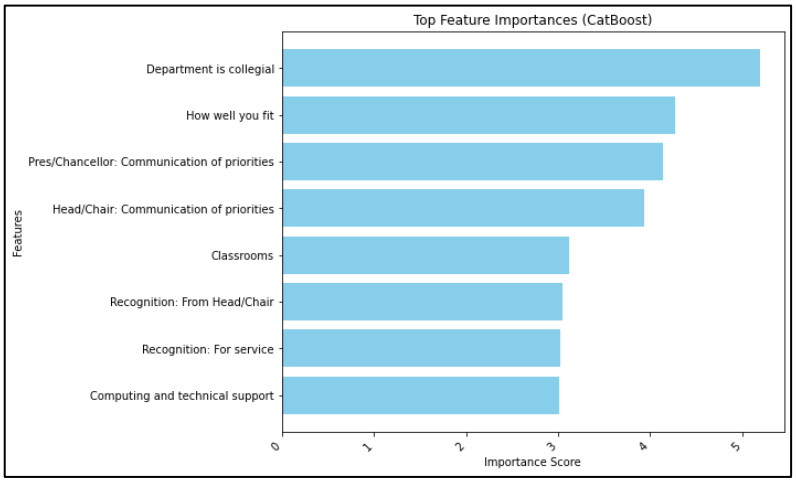

Figure 2: Top features identified by the model across satisfaction classes

Discussion

This study examined alignment between faculty satisfaction at departmental and institutional organizational levels. Using the Wilcoxon signed-rank test, we found a statistically significant difference with a moderate effect size (r = 0.266). Notably, the majority of faculty (n = 567) reported no difference between department and institution satisfaction—suggesting promising organizational alignment. Among those reporting differences, satisfaction was higher at the department level (n = 181) than at the institutional level (n = 86). Although our study design does not establish causality, a plausible explanation may be that departmental interactions more directly influence faculty's daily work experiences. Our model further validated this pattern, with five of the eight key predictive features being departmentally oriented.

Departmental Features

Collegiality ("Department is collegial") and belonging ("How well you fit") emerged as top features. This finding is consistent with literature suggesting the importance of connection and relatedness to be important for overall satisfaction of faculty [30]. Additionally, "Recognition from chair" and "Recognition for Service" emerged as important features, suggesting the importance of acknowledging faculty contributions. Such recognition has been identified as an important norm for establishing respect and positive departmental culture [13], [31].

Institutional Features

At the institutional level, resource-related factors like "Classrooms" and "Computing and technical support" were identified as top features. This finding is especially important given

well-documented research indicating that PT faculty often have limited access to institutional resources and often have higher teaching responsibilities [7]. As Blumberg [12] suggested, these resources provide faculty with opportunities to perform their jobs effectively.

Communication of Priorities

Notably, "President/Chancellor: Communication of priorities" and "Chair/Head: Communication of priorities" emerged as top features. This may suggest that for satisfaction alignment, consistent communication of priorities at both departmental and institutional levels is important. The communication of priorities has often been associated with leadership support and has been found to be relevant for faculty satisfaction in previous studies [32].

Conclusion

As PT instructional faculty continue to play a vital role in higher education, fostering alignment between departmental and institutional organizational structures will likely be important for improving faculty well-being, retention, and ultimately, student success. Our findings suggest that while most faculty experience alignment between departmental and institutional satisfaction, exceptions exist. When differences in satisfaction occur, faculty tend to favor their departments over institutions. Our model identified key factors influencing this relationship, including "Departmental is collegial" and "How well you fit" within their academic environments. Additionally, our analysis provided insights into potential alignment mechanisms related to "Communication of priorities" at various leadership levels (e.g., department chairs and presidents). Future research should continue to explore how these dynamics evolve over time, particularly considering the ongoing shifts in the higher education landscape. Understanding the nuanced dynamic between departmental and institutional satisfaction could lead to more effective strategies for supporting faculty across different appointment types and institutional contexts.

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