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Signals of inclusion: how faculty demographics impact the use of identity safety cues in undergraduate STEM syllabi

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In this study we explore the relationship between faculty demographics such as gender, academic rank, and field, and the presence of Identity Safety Cues (ISCs) in undergraduate course syllabi. ISCs, such as the inclusion of instructor pronouns, inclusivity statements, and materials authored by women and gender minority scholars, are increasingly seen as indicators of inclusive teaching practices. Drawing from an original dataset of 163 syllabi from introductory undergraduate courses at Worcester Polytechnic Institute, a STEM-focused institution in the United States of America, we examine how these cues are used by faculty across different fields, gender, and rank. We employ a combination of descriptive and predictive statistics methods to investigate the influence of faculty demographics on syllabi design. Our findings reveal that women faculty across all disciplines are more likely to include ISCs compared to their male counterparts. Field also plays a substantial role in syllabi design, with faculty in the Humanities & Arts including ISCs much more frequently than those in STEM and the Social Sciences. The implications of these findings suggest a need for targeted faculty professional development and mentorship to promote better inclusive pedagogy in STEM education.

KEYWORDS

inclusion, pedagogy, syllabi, identity safety cues, faculty demographics, STEM education, undergraduate education, higher education

1 Introduction

In recent years there has been a growing recognition of the importance of inclusivity in higher education. Inclusive teaching practices, particularly in Science, Technology, Engineering, and Mathematics (STEM) fields, are important for creating a learning environment where all students feel valued and supported (Kube et al., 2024; Savaria and Monteiro, 2017). One tool that can be used to implement inclusive teaching practices is the course syllabus. At first glance, syllabi might seem to simply reflect the course schedule and required readings. However, these documents convey the instructor's expectations, can shape the dynamics of the class environment, and signal to students the instructor's values and teaching strategies. Because of the timing at which syllabi are typically distributed, they are influential in setting the tone of a course and can be used to communicate the instructor's commitment to inclusivity (or lack thereof).

This study investigates the relationship between the demographics of instructors and the inclusivity of their course syllabi. Specifically, we consider three demographic axes for faculty: gender, rank, and field, and focus on the presence of three Identity Safety Cues

on syllabi that signal inclusivity: instructor pronouns, inclusivity statements, and the use of materials authored by women and gender minority scholars. Specification of personal pronouns in the context of the United States of America (U.S.A.) typically consists in clarifying whether to use, for example, "she/her," "he/him," or "they/them" (alone or in combination), when referring to oneself. Specifying one's pronouns not only indicates a person's gender identity, but it is typically associated with folks recognizing gender as a spectrum rather than a binary, and it signals support for the LGBTQIA+ community (Cabral and Pinto, 2023; Herek et al., 1991).

Inclusivity statements are often incorporated in syllabi to set the expectation that the instructor and students will not discriminate against others based on their background. Incorporating course materials written by women and gender minority authors frequently indicates that the instructor values diverse perspectives and aims to broaden the representation of who is considered an expert in the field. By examining syllabi from introductory undergraduate courses at Worcester Polytechnic Institute (WPI)—a private STEM-focused 4-year institution in Massachusetts, U.S.A.—we seek to understand how instructor characteristics such as gender, rank, and academic field influence syllabi inclusivity features.

Our research draws from an original dataset of 163 syllabi collected at WPI over six academic years, from 2016 to 2022. This dataset provides insight into syllabi inclusivity trends and reflects changes influenced by the COVID-19 pandemic. Through detailed analysis, we examine the role that faculty demographics play in shaping inclusive educational practices. In the following sections, we discuss inclusivity literature, present methods for data collection and analysis, and introduce our findings on the relationship between instructor demographics and the presence of Identity Safety Cues in course syllabi. Our results offer a clear view of who is contributing to inclusive pedagogy and who is lagging behind. We seek to identify differences in inclusive practices in STEM and non-STEM disciplines, between junior and senior faculty, and between women and men.

2 Literature review

Our previous study found that undergraduate students majoring in STEM subjects want their course syllabi to be more inclusive, yet many instructors fail to incorporate inclusive teaching practices (Bernardi et al., 2024). Building upon that study, we wanted to understand whether there is a connection between faculty background and their syllabi design. Recent research argues that creating syllabi and courses with an eye toward inclusivity in all subjects (but especially in STEM) could help improve the student experience in these fields (Maimon et al., 2021; Chaney et al., 2016; Savaria and Monteiro, 2017; Bernardi et al., 2024). This becomes particularly important when considering the distressingly low retention rates for underrepresented and marginalized groups in STEM, including women, students of color, and queer and non-binary students. These student populations often grapple with feelings of isolation and unwelcoming educational spaces in addition to the difficulty of the subject matter which can hinder their academic and social success (Hughes, 2018; Funk and Parker, 2018; Stout and Wright, 2016; Chang et al., 2014; Ashford et al., 2017). Examining how instructors' demographics and academic disciplines affect syllabi inclusivity can help identify who is already working on making their courses more inclusive and define strategies to expand these practices to a wider swathe of faculty.

2.1 The syllabus as a tool for inclusivity and student engagement

A class syllabus is so much more than simply a logistical document used to organize a course. It reflects the instructor's teaching style and shapes the learning environment for the student (DiYanni and Borst, 2020). Syllabi also function as contracts that guide students' learning experiences and serve as legal documents and enforceable agreements that outline academic norms and expectations along with students' rights and responsibilities (Soonpaa, 2018). Instructors have the academic freedom to design syllabi that meet educational standards set by the university and accreditation institutions, while also incorporating elements like inclusivity statements, grading scales, and course outlines (Hess and Whittington, 2003). Scholars have noted that students who read a multidimensional syllabus are "more likely to feel that course strategies have been designed to help them reach their goals, rather than merely as busywork or, worse, to torture them" (Littlefield, 1999, as cited in Slattery and Carlson, 2005, p. 159). The syllabus has become more than a tool to simply share course deadlines, exams, and required readings, it has become an extension of inclusivity.

Contrary to the common assumption that course syllabi are static documents that students do not engage with, students report reading and referring to syllabi throughout a course; they also recognize that incorporating inclusive language helps facilitate a more welcoming classroom environment (Bernardi et al., 2024). The language and tone used in syllabi significantly impact classroom experiences. An abrasive, punitive, or inflexible tone, along with a strict emphasis on course policies, can lead to negative outcomes for students and create spaces of "unbelonging" (Singham, 2005; Harnish and Bridges, 2011). To counter this, many instructors are adopting "trauma-informed" pedagogical approaches that prioritize sensitivity and flexibility to move away from punitive language (Munro, 2022; Thomas et al., 2019). These changes help create positive student-instructor relationships and encourage environments where students develop a sense of belonging and can obtain academic success (Gin et al., 2021, p. 224; Maimon et al., 2021).

An effective syllabus conveys the instructor's enthusiasm for teaching and invites students to engage more deeply with the course material (Chen et al., 2023, p. 23). Additionally, some instructors are beginning to include inclusivity statements, pronouns, land acknowledgments, accessibility statements, and content warnings to create inclusive and supportive learning environments for students (Maimon et al., 2021; Chaney et al., 2016). These strategies have been shown to improve retention and success for students with stigmatized identities (Maimon et al., 2021). However, if an instructor does not genuinely value or understand the messages sent by these pedagogical tools, including them in course materials

can be misleading. Authenticity in teaching practices is important to students; they are more likely to engage and feel supported in environments where the instructor's stated values align with their actions (Bartlett, 2023; Bernardi et al., 2024). Essentially, faculty should understand what signals are being sent to students when adding inclusive content on syllabi and should avoid using such tools if not prepared to stand by them; this will avoid further undermining students' trust in the instructor and the classroom environment (Bernardi et al., 2024, p. 9).

2.2 The impact of instructor identities on inclusive practices in STEM courses

An instructor's identities—such as their gender, race, ethnicity, class, (dis)ability, religion, nationality, status as a first-generation college student, etc.—can influence the way they teach and in turn their syllabi design. Educators from diverse or marginalized backgrounds often bring unique perspectives to their teaching, and their own experiences may increase their ability to understand the needs of a varied student body. For example, Ladson-Billings (1995) discusses how teachers of color may draw upon their cultural experiences to create more inclusive and culturally responsive curricula. Additionally, instructors who are first-generation college graduates may be particularly attuned to the challenges faced by students who are navigating higher education without a familial model and may choose to include specific resources on a syllabus to address these issues (Jehangir, 2010). Research also supports the notion that an instructor's gender impacts the inclusivity of their university classroom. For instance, women instructors are more open to incorporating inclusive classroom policies and practices compared to their male counterparts (Boyle et al., 2013; Álvarez and Buenestado, 2015; Avramidis and Norwich, 2002; Wray et al., 2022). However, studies also observed that men instructors become more prone to implementing inclusive educational practices in their classes when they receive proper training (Emmers et al., 2020; Llorent and Alamo, 2016).

Our study examines how instructors' rank and disciplinary field, along with gender, influence syllabi design strategies, expanding the existing research on inclusive classroom environments. While previous studies have shown that the gender identity of an instructor can play a role in creating inclusivity, there is limited research on how characteristics beyond gender impact this dynamic. For instance, Maimon et al. (2021) found that the use of Identity Safety Cues (ISCs) on syllabi fostered a greater sense of belonging and a more positive impression of the instructor among students, regardless of whether the instructor was a White man or a White woman. Their findings suggest that the use of ISCs has a more significant effect on student perceptions than the instructor's gender alone (Maimon et al., 2021). We build on the existing literature by examining how instructors' rank and field influence their syllabi design strategies along with gender.

This study tests who is utilizing Identity Safety Cues on their syllabi, with a dataset which includes faculty from various ethnic and racial backgrounds along with other intersecting identities, not simply White women and men. We examine how an instructor's rank and field of study, along with gender, influenced their use of ISCs on syllabi. Our primary objective was to determine the characteristics of faculty more likely to use Identity Safety Cues in their classrooms.

2.3 Critiquing assumptions of objectivity and faculty influence in STEM

STEM's reliance on empirical methods is often equated with objectivity, but this view ignores the influence of structural biases. The idea of objectivity in STEM assumes that the identity of the instructor or author of a textbook is irrelevant. However, this perspective overlooks how teaching methods, course materials, and examples shape the curriculum and students' understanding of the discipline (González-Castellano et al., 2021). By excluding diverse views and privileging canonical texts, STEM education can perpetuate systemic biases and reinforce existing power structures (Levya et al., 2022).

Research highlights how STEM curricula are neither neutral nor detached from sociocultural contexts. For instance, large datasets commonly used in statistics and machine learning courses often embed and perpetuate societal inequalities, reinforcing stereotypes related to gender, race, and other identities (Angwin et al., 2016; Buolamwini and Gebru, 2018; Caliskan et al., 2017; Bolukbasi et al., 2016). Textbooks and syllabi reflect the values of instructors and institutions, influencing both the framing of content and the inclusivity of the classroom (Parson, 2016). Thoughtfully designed syllabi can serve as tools to promote equity in STEM, especially for students from marginalized backgrounds (Calabrese Barton and Tan, 2019; Gutiérrez, 2018).

Critically examining STEM education requires addressing not only what is taught but also how it is taught. Faculty's decisions about syllabi design—such as including course materials written by authors from diverse backgrounds and signaling a commitment to equity—play a crucial role in reshaping traditional power dynamics and creating a more just academic environment (Harding, 1992; Prescod-Weinstein, 2020). By recognizing that scientific knowledge is influenced by dominant cultural perspectives, educators can better align their teaching with the needs of all students, fostering inclusivity and social change in a historically exclusionary field (Calabrese Barton and Tan, 2019).

3 Materials and methods

To investigate the relation between faculty demographics and the inclusivity of their course syllabi, we collected and analyzed 163 syllabi from introductory undergraduate courses at Worcester Polytechnic Institute. This dataset provides insight into faculty syllabi habits and customs beyond the scope of this manuscript (Bernardi et al., 2024); here, we focus on how instructor characteristics such as gender, rank, and field, influence the presence of three Identity Safety Cues that serve as key inclusivity features in course syllabi: (a) instructor pronouns, (b) inclusivity statements, and (c) materials authored by women and gender minority scholars.

3.1 Worcester Polytechnic Institute context

Worcester Polytechnic Institute (WPI) is a private four-year research university in Worcester, Massachusetts (U.S.A.), that primarily focuses on STEM disciplines.[1] The university serves undergraduate and graduate populations of just over 5,000 and 1,500 students, respectively (WPI Institutional Research, 2024). WPI's student demographics share many characteristics with peer institutions. In the Fall of 2023, WPI's undergraduate enrollment was approximately 5,300 students, with 65% identifying as male and 63.5% as White. Less than 3% of students identified as Black or African American, and <9% as Hispanic or Latinx (WPI Institutional Research, 2024). The gender ratio at WPI has seen significant fluctuations in the past few years. For instance, while the ratio of women to men in the undergraduate class of 2025 was closer to parity with 43% of 1st-year students identifying as women, this percentage dropped to about 30% for the class of 2027 (WPI Institutional Research, 2024).[2]

Gender discrepancies persist across disciplines and degree programs on campus, reflecting broader trends within STEM fields. The most popular majors, such as Computer Science and Mechanical Engineering, exhibit a male-to-female ratio of approximately 3:1. In contrast, Biomedical Engineering—the third most popular major—is an exception, with almost twice as many women as men (WPI Institutional Research, 2024). We believe instructors play a crucial role in fostering a culture of inclusivity in the classroom and view the syllabus as an accessible tool to reach such goals.

3.2 Syllabi dataset

We gathered 163 syllabi from introductory level courses by soliciting volunteer participation from all faculty at WPI. We chose to focus on introductory courses because they constitute the majority of classes 1st-year and sophomore students enroll in regardless of their major; additionally, these courses often serve as "weed out" classes, gatekeeping students' advancement in their chosen majors. We began this project in 2021 and gathered syllabi from six academic years, from 2016–2017 to 2021–2022. We are cognizant of the fact that many faculty updated their syllabi to adjust learning priorities amidst the COVID-19 pandemic and other societal shifts starting in the Spring of the 2019–2020 academic year. While our goal was not to focus specifically on these changes, they inevitably impacted our dataset. We label "pre-COVID-19" the syllabi for courses between 2016 and 2019, as well as courses in C-term (January to March) 2020.[3] Similarly, we use the "COVID-19" label when considering all syllabi in our dataset from D-term 2020 forward.[4]

To represent student enrollment proportionally, we collected syllabi based on the number of students each department served in 1,000- and 2,000-level courses. We used enrollment numbers for the academic year 2020–2021—the most recent year for which enrollment data was available when we started this research (WPI Institutional Research, 2024). WPI has 18 departments and 21 programs distributed among the School of Arts & Sciences, the School of Engineering, the Business School, and the Global School. Our data comprises syllabi from all four schools, 14 departments, and 1 program, as reported in Table 1 of Bernardi et al. (2024). Some departments in the School of Engineering and most programs do not offer 1,000- and 2,000-level courses and therefore are absent from the dataset. We also excluded syllabi from special interest or non-departmental programs, such as Physical Education, Military Science (Army Reverse Officers' Training Corps, ROTC), and Air Force Aerospace Studies (Air Force Reverse Officers' Training Corps, AFROTC).

We note that a few syllabi in our dataset ($n = 6$ of 163) were designed by multiple instructors who co-taught a course. The goal of this study is to relate faculty demographics to syllabi inclusivity, so these instructors were considered separately and treated as if they each had submitted their own syllabus. This choice accounts for the actual number of instructors in the dataset ($n = 169$) by generating an artificial increase in the number of syllabi from 163 to 169.

3.3 Syllabi review and analysis

An interdisciplinary group of six WPI faculty members analyzed the syllabi dataset in 2022. To maintain the anonymity of instructors who voluntarily shared their syllabi, a student worker de-identified the files labeling them by the department code and a number; e.g., CH2 was the name assigned to the 2nd syllabus submitted from the Department of Chemistry (CH). Then, the syllabi were anonymized, and their metadata was saved to a separate spreadsheet.

Syllabi were scored with 0 or 1 depending on whether they listed each of the three Identity Safety Cues (ISCs) of interest: instructor pronouns, inclusivity statements, and materials written by women and gender minority authors. For detailed information on how the faculty analyzed the syllabi, see Bernardi et al. (2024); Appendix 1 contains the custom-made rubric used to score each syllabus in the dataset. While our rubric allows for a broad analysis of syllabi content, we continue to focus on these three ISCs as valuable signals of faculty's inclusive teaching practices. We consider three demographic axes: gender, rank, and field, and study their influence on syllabi design as described in the sections below.

1 Based on the recently updated classification guidelines, the American Council on Education and Carnegie Foundation for the Advancement of Teaching will classify WPI as an "R1" institution beginning in 2025 (American Council on Education, 2023).

2 WPI gathers publicly accessible student data along the gender binary, only offering men and women as gender options (WPI Institutional Research, 2024).

3 The academic year at WPI is divided into four terms, with terms A and B spanning the Fall semester separated by Fall Break, and terms C and D spanning the Spring semester separated by Spring Break. Each term is 7 weeks long and undergraduate courses last one term. Students typically take three courses per term.

4 On March 13th, 2020, COVID-19 was declared a national emergency (Trump, 2020). On March 18th, 2020, WPI announced that all D-term classes would be offered remotely (WPI Office of the President, 2020).

TABLE 1 Comparison of syllabi and IPEDS datasets by faculty rank.

Time period	Professor	Associate professor	Assistant professor	Instructor
Pre-COVID-19 ($n = 38$)	$-8.32\% \pm 12.52\%$	$9.31\% \pm 15.23\%$	$-1.59 \pm 11.74\%$	$0.61\% \pm 13.16\%$
COVID-19 ($n = 131$)	$-4.07\% \pm 7.69\%$	$4.17\% \pm 7.69\%$	$-6.64\% \pm 5.52\%$	$6.53\% \pm 8.86\%$

0.0-2.5% 2.5-5.0% 5.0-7.5% 7.5-10.0%

Table 1 shows the difference in percentage of folks with each rank along with confidence intervals, before and during the COVID-19 pandemic. The negative (positive) numbers appearing in the table identify the rank categories underrepresented (overrepresented) in our syllabi dataset; differences for each category are computed as follows: (percentage in syllabi dataset) – (percentage in IPEDS dataset). A difference of 0% would mean that our syllabi dataset has the exact same percentage of faculty in a specific category as reported on IPEDS. Confidence intervals are computed based on equation (2). When 0% is within the confidence interval our data is representative of IPEDS data. The n-values shown in the table are from the syllabi dataset; to see the corresponding n-values for IPEDS and further information about individual percentages and number of people per category, see Supplementary material 1.

3.3.1 Gender

Out of the 169 instructors who voluntarily contributed their syllabi to our dataset, 72.8% were men and 27.2% women. This gender classification is based on online searches of faculty names, pictures, and pronouns (if any) on their professional or personal websites, and LinkedIn profiles. We acknowledge the limitations of leveraging such information to infer people's gender or racial identities (Wood et al., 2020, p. 2–3) along with a two-option-only classification; however, we chose to divide instructors along the gender binary to compare our dataset directly to the publicly available Integrated Postsecondary Education Data System (IPEDS) (National Center for Education Statistics, 2024). According to IPEDS, the gender distribution of WPI faculty hovered around 70% men and 30% women between 2016 and 2022. Figure 1 displays this IPEDS-reported gender breakdown (dots) alongside the 95% confidence intervals from our dataset (shading), with men shown in red and women in purple. We calculate the confidence bounds for the proportion p for either men or women as:

$$p \pm z\sqrt{\frac{p\,(1-p)}{n}}, \tag{1}$$

where $z = 1.96$ is the z-score at a 95% confidence level and n is the sample size for a given time (Maindonald and Braun, 2006, p. 113).

The figure also separates the data into two periods: pre-COVID-19 (2016 to March 2020) and COVID-19 (March 2020 onward); the pre-COVID-19 percentages are based on faculty data from academic years 2016–2017 to 2019–2020 (n = 1,582, with 1,100 men and 482 women), and the COVID-19 percentages reflect academic years 2019–2020 to 2021–2022 (n = 1,164, 867 men and 377 women).[5] Notably, 2019–2020 employees are counted in both groups due to a lack of term-specific IPEDS data. Our dataset accurately reflects the overall WPI faculty population during the COVID-19 years, as the IPEDS percentages fall within our confidence intervals, but performs less well for pre-COVID-19 years, where the IPEDS percentages fall slightly outside our confidence intervals. This is likely due to a smaller number of syllabi in our dataset for that time period (n = 38, with 32 men and 6 women, compared to n = 131 for the COVID-19 period, with 91 men and 40 women).

5 The actual number of faculty employed at WPI over the pre-COVID-19 and COVID-19 periods is not 1582 and 1164, respectively, but much smaller. This is because most of the faculty employed in a certain year were still employed the following year, but since the data is in aggregate form, there is no way of tracking individual faculty over the years.

3.3.2 Rank

In 2021, WPI introduced a teaching path to tenure, and 43 instructors have been selected for these positions since then (Flaherty, 2021). WPI now has two types of tenure-track lines: one for teaching faculty and one for dual-mission (teaching and research) faculty. Both tenure lines follow the same rank progression—assistant, associate, and full professor—but titles differ, with "of teaching" added to the ranks for teaching-focused faculty.

Following the IPEDS classification, we grouped instructors who submitted syllabi into four rank categories: assistant professor, associate professor, professor, and instructor. The instructor category includes all fixed-term faculty (e.g., adjuncts, lecturers, and post-docs). Assistant, associate, and professor categories include both teaching and dual-mission faculty. Table 1 compares the percentage of faculty in each rank in our syllabi dataset to IPEDS, before and during the COVID-19 pandemic. We evaluate the difference between the dataset based on its magnitude rather than sign and assign more intense cell shading as the discrepancy between datasets increases (regardless of sign). A difference of 0% indicates that our dataset matches IPEDS exactly; the closer the value is to 0% the better our dataset represents the true WPI faculty rank distribution. See Supplementary material 1 for additional information.

We compute the confidence bounds for the proportion of the category of interest (each rank, before or during the pandemic) as:

$$z\sqrt{\frac{p\,(1-p)}{n} + \frac{P\,(1-P)}{N}}, \tag{2}$$

where, again, $z = 1.96$ is the z-score at a 95% confidence level, p and P are the percentages of people belonging to the chosen category in our dataset and IPEDS, respectively, n is our dataset sample size, and N is the IPEDS sample size for a given time period (Diez et al., 2015, Section 6.2).

Our goal is to assess how representative our dataset is compared to the IPEDS. We consider two criteria: first, how close the percentage differences are to 0%, and second, whether 0% falls within our confidence intervals. Overall, our dataset closely matches the IPEDS breakdown, with only two categories in the pre-COVID-19 grouping showing discrepancies over 7.5%, likely due to the smaller number of syllabi (n = 38 vs. n = 131 during COVID-19). At a 95% confidence level, all categories except Assistant Professors during COVID-19 include 0% within their confidence intervals, suggesting that our dataset generally represents the WPI faculty breakdown well despite its small size (n = 169).

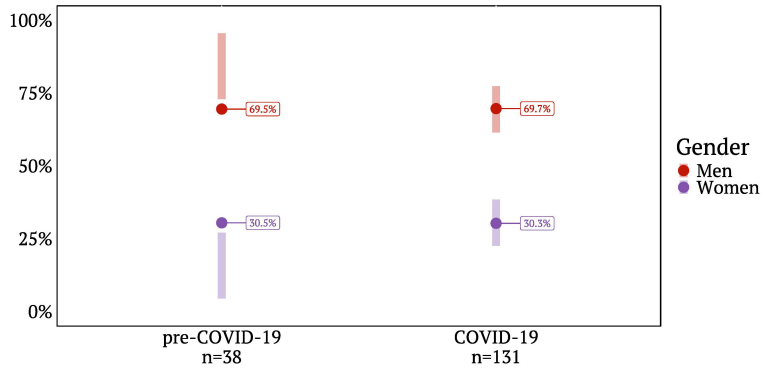

FIGURE 1
Comparison of gender breakdown for WPI faculty over the years: Integrated Postsecondary Education Data System (IPEDS) (dots) and confidence intervals of our syllabi dataset ($n = 169$, 95% confidence level, shading). The 6 years covered by our dataset are separated into pre-COVID-19 (2016 to March 2020, left) and COVID-19 (March 2020 or later, right). The binary gender classification (men in red, women in purple) is chosen to compare directly to the publicly available IPEDS (National Center for Education Statistics, 2024). For IPEDS, percentages are computed based on the gender breakdown of faculty employees by year (since IPEDS information by term is not available); pre-COVID-19: $n = 1,582$, with 1,100 men and 482 women; COVID-19: $n = 1,164$, 867 men and 377 women. IPEDS employees' data for 2019–2020 was considered both as part of the pre-COVID-19 and COVID-19 time periods. Confidence intervals are computed based on equation (1); pre-COVID-19: $n = 131$, with 91 men and 40 women; COVID-19: $n = 38$, 32 men and 6 women.

3.3.3 Field

The School of Arts & Sciences at WPI serves most students in their first 2 years on campus, with 83.7% of student enrollment in 2020–2021 (WPI Institutional Research, 2024). However, not all instructors within the same school (or even the same department or program) behave similarly when it comes to syllabi inclusivity. As such, we decided to use instructors' *field*, rather than departmental affiliation, as one of the demographic axes in our syllabi analysis.

In Figure 2 we report the percentage of syllabi in our dataset that belongs to each field. We grouped faculty separating those in the Sciences (18.9%), Technology (10.7%), Engineering (14.2%), Mathematical Sciences (22.8%), Humanities & Arts (20.7%), and the Social Sciences (13%). We merged the departments or programs of Biology and Biotechnology, Chemistry, and Physics under Science; Data Science and Computer Science under Technology; Biomedical Engineering, Chemical Engineering, Civil and Environmental Engineering, Electrical and Computer Engineering, and Mechanical and Materials Engineering under Engineering; and Business, Integrative and Global Studies, and Social Science and Policy Studies under Social Sciences. We only kept two departments on their own: Mathematical Sciences and Humanities & Arts; these are the departments that serve the most students in their first 2 years on WPI campus and for which we have the most syllabi ($n = 38$ and $n = 35$, respectively). Departments that do not appear in our field breakdown did not submit syllabi for our dataset.

3.4 Predictive techniques and tools

In our analysis we used both descriptive and predictive statistics to understand syllabi content and how it relates to faculty demographics. Descriptive statistics provide a clear summary of the inclusivity features of the 169 syllabi collected (see Results Sections 4.1–4.3). To understand the influence of faculty demographics on the design of their course syllabi, we calculated measures of central tendency and variability and identified general patterns in the syllabi at our disposal.

We used a predictive classification tree algorithm to identify the demographic factors that are most important and influence certain inclusivity outcomes. This approach is ideal for handling categorical and binary data and produced the most accurate predictions for our dataset. Basic linear regression and logistic regression do not work well when comparing different categorical data such as the variables "Instructor" and "MATH." Although we did consider more complex models, like random forests or boosted models, these algorithms are typically designed for large datasets, and with only 169 data points, an overly complex model is unnecessary. Classification trees achieved the highest prediction accuracy for our data, and they are more intuitive and easier to interpret, making them ideal for our analysis.

We build classification trees to predict what faculty demographic characteristics influence the most whether a syllabus includes a specific Identity Safety Cue (ISC). We predict the binary outcome of whether syllabi do or do not include a certain ISC (y variable), and consider each field, gender, and rank as a separate (x) variable, rather than grouping them within the three demographic axes.

For our dataset, at each node the tree algorithm evaluates all possible variables among the gender, rank, and field options (always categorical or binary). The variable that provides the highest information gain and enhances the model outcomes is selected; then, the data is split into two branches, with one branch representing data which contains the selected variable, and the other representing data that does not. The process continues with further splits along each branch until the model is ready to make a prediction about whether the data contains the selected y variable or not, with the best possible accuracy. Classification trees were produced using the R statistical package **rpart** which provides advanced tools for precise analyses and reliable results (Therneau

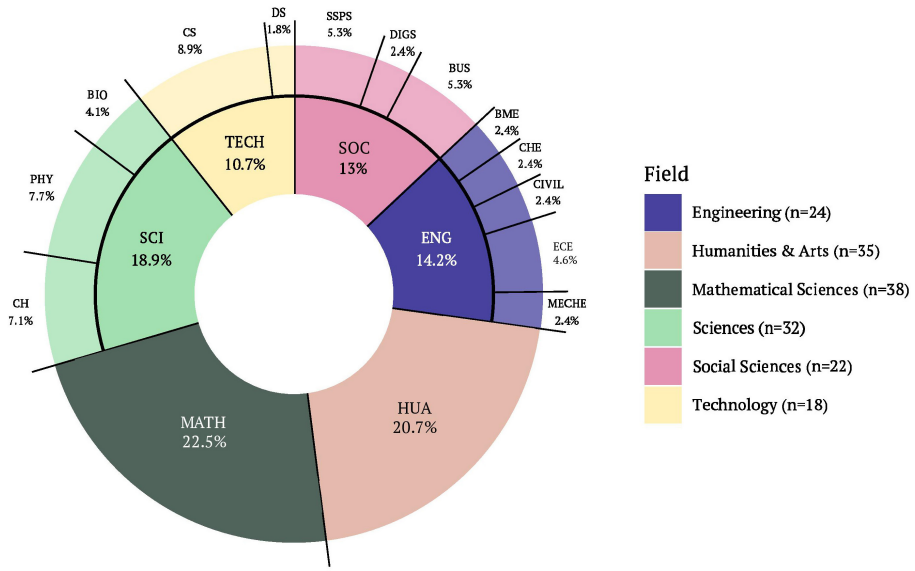

FIGURE 2
Percentage of syllabi in our dataset based on faculty's field ($n = 169$). Fields are grouped as follows: Biology and Biotechnology ($n = 7$), Chemistry ($n = 12$), and Physics ($n = 13$) are considered Sciences (18.9%); Data Science ($n = 3$) and Computer Science ($n = 15$) are grouped under Technology (10.7%); Biomedical Engineering ($n = 4$), Chemical Engineering ($n = 4$), Civil and Environmental Engineering ($n = 4$), Electrical and Computer Engineering ($n = 8$), and Mechanical and Materials Engineering ($n = 4$) are considered Engineering (14.2%), and Business ($n = 9$), Integrative and Global Studies ($n = 4$), and Social Science and Policy Studies ($n = 9$) are merged under Social Sciences (13%). Mathematical Sciences ($n = 38$, 22.8%) and Humanities and Arts ($n = 35$, 20.7%) are the only two departments chosen to represent their own field. WPI departments and programs that do not appear in this field breakdown did not submit syllabi for our dataset.

and Atkinson, 2022). Further details about the implementation and analysis of our classification tree algorithm are provided in Supplementary material 2.

4 Results

We were interested in exploring the influence of faculty demographics on their class syllabi design. Specifically, we considered how faculty gender, rank, and field affected the presence of the three Identity Safety Cues (ISCs) we chose as measures of inclusivity: instructor pronouns, inclusivity statements, and instructional materials authored by women and gender minority scholars. While our syllabi dataset ($n = 169$) cannot be representative of faculty habits at all institutions, we believe it provides useful insights in the trends on our campus and may be a starting point for reflection on who is shouldering the work of making inclusive pedagogy a priority in undergraduate STEM education.

4.1 Faculty gender and Identity Safety Cues

We first investigated how the gender of instructors affects the inclusion of our three Identity Safety Clues of interest on course syllabi; here, we maintain the binary gender distinction discussed in Section 3.3.1. Figure 3 shows a treemap chart representing syllabi ISC content based on faculty gender; to improve readability, we label pronouns as P, inclusivity statements as IS, and materials written by women and gender minority authors as GMA. The area of each color-coded column is meant to underline the difference in sample size by gender; our dataset includes about 2.5 as many syllabi authored by men ($n = 123$, red) compared to syllabi written by women ($n = 46$, purple). The size of individual boxes is matched to the percentage of syllabi that contains the specific ISC(s) for each gender. That is, for example, the largest box in Figure 3 is red and labeled as "None 67.5%" to indicate that 67.5% of the syllabi in our dataset authored by men (83 of 123) do not include any of the ISCs of interest. Interestingly, the corresponding percentage for women instructor is 23.9% (11 of 46 syllabi). Only 0.8% of syllabi authored by men (1 of 123) include all ISCs while the percentage (and number) is much larger for women instructors (17.4%, 8 of 46).

Inclusivity statements are the most used ISC across all instructors (appearing alone or in combination with other ISCs in 24.4% of syllabi authored by men and 58.7% authored by women), followed by the use of course materials produced by women and gender minority authors (13% for syllabi written by men and 39.1% for syllabi written by women), and finally pronouns (4% and 23.9% for syllabi created by men and women, respectively). Notably, all syllabi authored by women which include pronouns also include inclusivity statements ("P & IS 6.5%") while the same is not true for men. Overall, the visualization in Figure 3 shows how in our dataset women instructors are using Identity Safety Cues more frequently than men.

4.2 Faculty rank and Identity Safety Cues

Next, we considered how faculty rank influences the inclusion of pronouns, inclusivity statements, and materials produced by

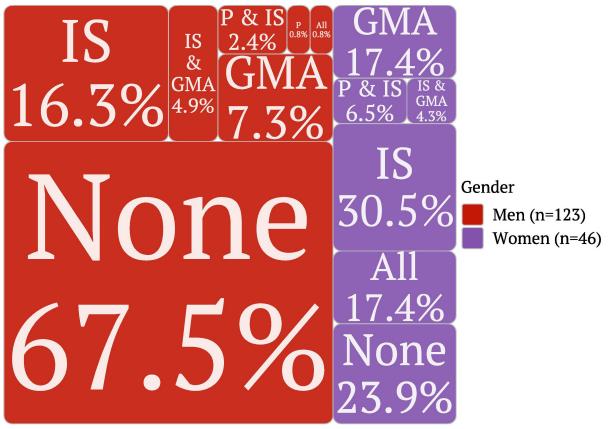

FIGURE 3
Treemap chart representing syllabi Identity Safety Cues content based on faculty gender. ISCs are labeled as follows: P, pronouns; IS, inclusivity statements; GMA, materials written by women and gender minority authors. Gender definitions are provided in Section 3.3.1. Our dataset includes $n = 123$ syllabi authored by men (red) and $n = 46$ authored by women (purple); the size of each column matches gender-based sample size. The size of individual boxes is matched to the percentage of syllabi that contains the specific ISC(s) for each gender (computed based on the gender-specific n-value).

women and gender minority authors on course syllabi; here we use the rank categorization introduced in Section 3.3.2. Figure 4 is a four-column stacked bar chart representing syllabi ISC content organized by faculty rank. Left to right, we first show the overall percentage of syllabi in our dataset authored by faculty with each rank. Of the $n = 169$ syllabi, 67 (39.7%) were written by faculty within the instructor category, which includes all fixed term faculty on campus. The remaining syllabi are distributed among assistant professors (19 syllabi, 11.2%), associate professors (45 syllabi, 26.6%), and professors (38 syllabi, 22.5%), each category including both teaching stream and dual-mission faculty.

Then, we consider one at a time the syllabi presenting each of the ISCs, alone or in combination, and show the percentages of those syllabi authored by faculty in each rank category; the second, third, and fourth columns of Figure 4 represent syllabi with women and gender minority authors, inclusivity statements, and pronouns, respectively. Our dataset includes $n = 34$ syllabi enlisting materials produced by women and gender minority authors (second column). A little less than half of these were written by instructors (44.1%, 15 syllabi), followed by professors (26.5%, 9 syllabi), and lastly by assistant and associate professors (with 14.7% each, 5 syllabi). Of the $n = 57$ syllabi which incorporate inclusivity statements (third column), about one quarter were created by professors (24.6%, 14 syllabi) and 45.6% by instructors (26 syllabi). Our dataset includes only $n = 16$ syllabi with pronouns (fourth column) over half of which were authored by faculty in the instructor category (56.2%, 9 syllabi).

Finally, our dataset also contains 94 (of 169) syllabi with no ISCs, not represented in the last three columns of Figure 4; of these, 37 were created by instructors, 8 by assistant professors, 31 by associate professors, and 18 by professors (for a summary of this data, see Supplementary Table 3). As such, the syllabi with no ISCs account for 55.2% of those written by instructors (37 of 67), 42.1% of those created by assistant professors (8 of 19), 68.9% by associate professors (31 of 45), and 47.4% of those produced by professors (18 of 38). Assistant professors use the most Identity Safety Cues overall, with 57.9% of their syllabi including at least one ISC. Professors follow, with 52.6% of syllabi having at least one ISC. Further behind are instructors and associate professors, whose syllabi include at least one ISC <50% of the time (44.8% and 31.1%, respectively).

4.3 Faculty field and Identity Safety Cues

Lastly, we were interested in understanding how faculty from different academic fields handle the inclusion of Identity Safety Cues in course syllabi. We based our analysis on the field breakdown introduced in Section 3.3.3, which groups syllabi in our dataset in 6 fields: Engineering, Humanities & Arts, Mathematical Sciences, Sciences, Social Sciences, and Technology, as visualized in Figure 2. Specifically, in Figure 5 we consider the number of syllabi with each ISC by field. We feature three histograms side by side showing syllabi with materials authored by women and gender minority authors (left), inclusivity statements (center), and pronouns (right), alone or in combination. Each histogram bar represents one field, and its height matches the number of syllabi from that field appearing in our dataset (also listed in the legend). The filled-in coloring, and corresponding numerical label, indicate how many of the syllabi in each field include the ISC in question. Bars are color-coded based on the field to match Figure 2.

We can see that of the Engineering syllabi collected (portrayed in blue as the first bar on the left in each histogram), 5 include materials written by women and gender minority authors (left), 7 include inclusivity statements (center), and 0 include pronouns (right). Here, as in Figure 4, we simply bin each syllabus which includes an ISC in the corresponding histogram regardless of whether it includes other ISCs. As such, due to Identity Safety Cues overlap, it is possible that the number of syllabi with no ISCs is higher than it appears in this visualization. We report the number of syllabi with no ISCs by field in Supplementary Table 4.

Identity Safety Cues are used most frequently in the Humanities & Arts, where approximately 46% of syllabi include materials written by women and gender minority scholars, almost 63% have inclusivity statements, and about 29% have pronouns. The field where ISCs appear the least is Technology, where 0 syllabi include materials produced by women and gender minority authors or pronouns, and only about 17% have inclusivity statements. Inclusivity statements are the only ISC employed in at least one syllabus in each field.

We take a closer look at the two fields with the highest number of syllabi in our dataset, Mathematical Sciences ($n = 38$) and Humanities & Arts ($n = 35$). Recall that we collected syllabi to match student enrollment data (as described in Section 3.2), so these two fields count the largest number of syllabi because the corresponding departments serve the largest number of students in their first and sophomore years on WPI campus. The upset plots in Figure 6 provide a detailed look at syllabi content in Mathematical Sciences (MATH), Figure 6A, and Humanities & Arts (HUA),

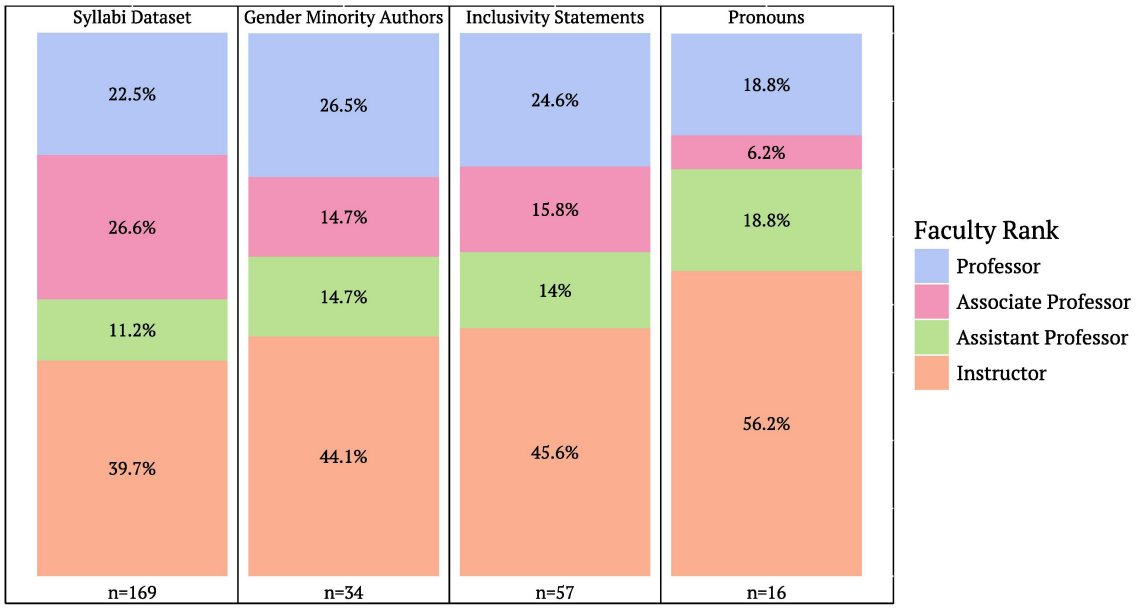

FIGURE 4
Four-column stacked bar chart representing syllabi Identity Safety Cues content based on faculty rank. Rank definitions are provided in Section 3.3.2. Left to right, the first column shows the overall percentage of syllabi in our dataset authored by faculty with each rank ($n = 169$). The second column only considers syllabi which include women and gender minority authors (alone or in combination with other ISCs, $n = 34$) and shows the rank breakdown for the authors of these syllabi. Similarly, the third and fourth columns show the rank breakdown for the authors of syllabi incorporating inclusivity statements ($n = 57$) and pronouns ($n = 16$), respectively. We bin syllabi containing each ISC individually without considering whether multiple ISCs appear simultaneously. Our dataset also contains 94 (of $n = 169$) syllabi with no ISCs, not represented in the last three columns; for a detailed breakdown of syllabi with no ISC by faculty rank, see Supplementary Table 3.

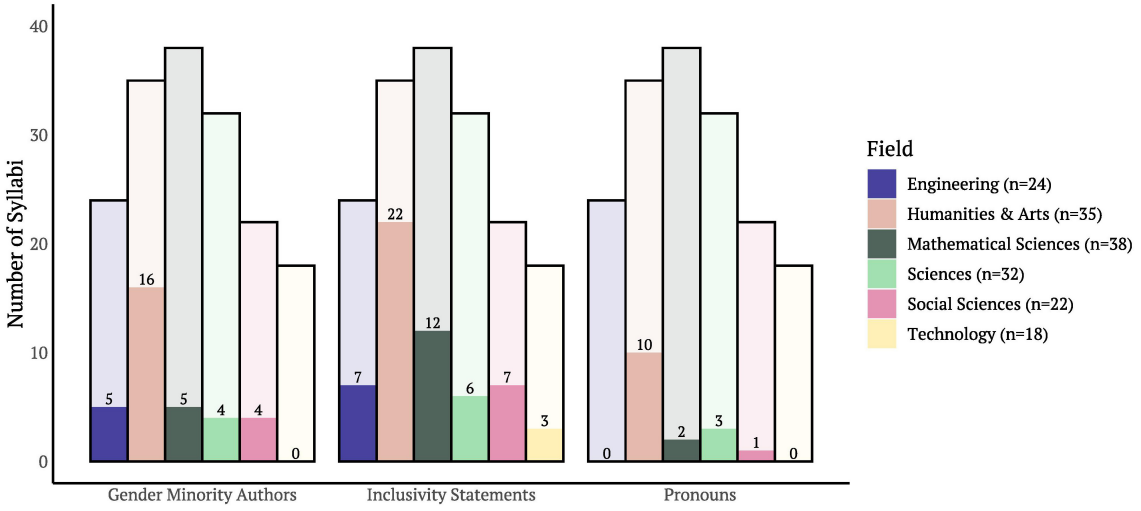

FIGURE 5
Three side by side histograms representing the presence of Identity Safety Cues in our syllabi dataset by field. Field definitions are described in Section 3.3.3. Histogram bars represent the syllabi in each field, color-coded across the three histograms to match Figure 2; bar heights match the n's reported in the legend. The filled-in coloring and corresponding label shows the number of syllabi for each field which include gender minority authors **(left)**, inclusivity statements **(center)**, and pronouns **(right)**. Here, we bin syllabi containing each ISC individually without considering whether multiple ISCs appear simultaneously. Our dataset also contains 94 (of $n = 169$) syllabi with no ISCs, not represented in these graphs; for a detailed breakdown of syllabi with no ISC by field, see Supplementary Table 4.

Figure 6B. On the right of each figure, the large histogram bars showcase the number of syllabi that present each Identity Safety Cue, using the same shorthand labels as in Figure 3: P for pronouns, IS for inclusivity statements, and GMA for materials written by women and gender minority authors. The filled-in dots below the histogram bars indicate which ISC (or combination thereof) is being considered in each bar. That is, for example, the leftmost bar counts how many syllabi contain all three ISCs; this is represented

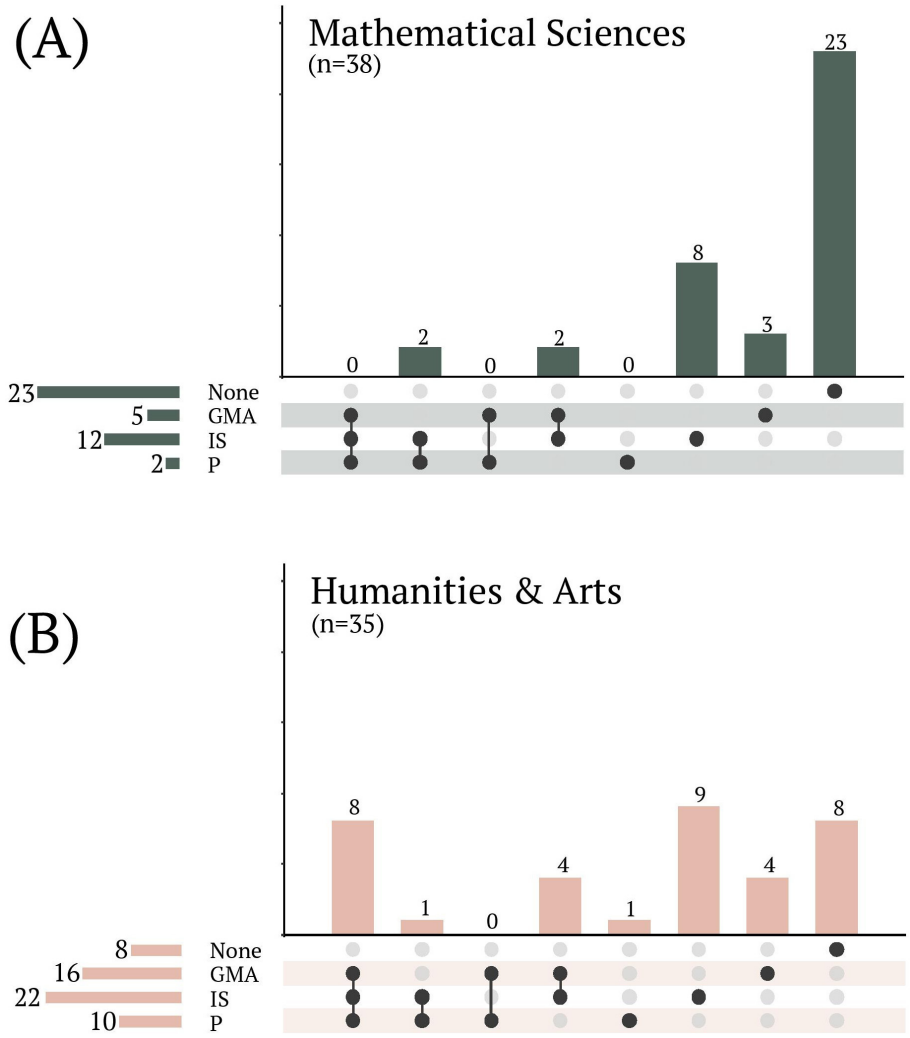

FIGURE 6
Upset plots showcasing the number of syllabi with Identity Safety Cues for the fields of **(A)** Mathematical Sciences ($n = 38$, top) and **(B)** Humanities and Arts ($n = 35$, bottom). In each subfigure, the large histograms on the right count the number of syllabi with pronouns (P), inclusivity statements (IS), and materials authored by women and gender minority authors (GMA) alone or in combination. The filled-in dots beneath the histogram bars indicate which ISC (or combination thereof) is being considered. Left to right, we show how many syllabi present: all three ISCs, inclusivity statements and pronouns, pronouns and gender minority authors, gender minority authors and inclusivity statements, pronouns, inclusivity statements, materials authored by women and gender minority authors, and no ISCs. The total number of syllabi which includes each of the ISCs is visualized in the summary horizontal bar graphs on the bottom left of each subplot. ISCs are listed on a separate row and the horizontal bars count the total number of syllabi that include that ISC alone or in combination. We report the total number of syllabi with no ISCs in the first row, with materials written by women and gender minority authors in the second row, with inclusivity statements in the third row, and with pronouns in the fourth row.

below the bar by connecting the filled-in dots for each ISC. Zero syllabi include all ISCs for Mathematical Sciences (Figure 6A) while 8 do for Humanities & Arts (Figure 6B).

Continuing left to right, we identify how many syllabi include both inclusivity statements and pronouns (2 for MATH and 1 for HUA), pronouns and gender minority authors (0 for both fields), and gender minority authors and inclusivity statements (2 and 4 for MATH and HUA, respectively). Next, we consider one ISC at a time; 0 syllabi in Mathematical Sciences (Figure 6A) and 1 in Humanities & Arts (Figure 6B) include only pronouns as an ISC. Looking exclusively at inclusivity statements, we count 8 syllabi in MATH and 9 in HUA in this group. Then, 3 syllabi in Mathematical Sciences and 4 in Humanities & Arts include only materials authored by women and gender minority authors. Finally, we report that 23 Mathematical Sciences syllabi have no Identity Safety Cues, as opposed to 8 Humanities & Arts syllabi (Figures 6A, B, respectively).

The total number of syllabi which include each of the ISCs is visualized in the summary horizontal bar graph shown on the left of each upset plot. Each ISC is listed on a separate row and the corresponding horizontal bar on the left counts the total number of syllabi that include that ISC (or no ISCs for the first row). For example, the fourth row in Figure 6B shows how many Humanities & Arts syllabi include pronouns (P): 8 have all ISCs, 1

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has inclusivity statements and pronouns, 0 include pronouns and materials authored by women and gender minority scholars, and 1 has pronouns only, for a total of 10 syllabi with pronouns. It is clear from this deeper dive into the characteristics of syllabi in these two fields, that faculty in the Humanities & Arts tend to use more ISCs than those in the Mathematical Sciences, with almost twice as many syllabi (27 of 35, approximately 80%) which include at least one ISC in HUA compared to MATH (only 15 of 38, approximately 40%). For both fields, inclusivity statements are the most used ISC, appearing alone or in combination with others in 12 of the 15 syllabi which include at least one ISC for Mathematical Sciences and in 22 of 27 syllabi for Humanities & Arts. Similarly, for both fields the least common ISC is pronouns, which appear only on 2 syllabi for MATH and 10 syllabi for HUA. It is worth noting that our entire dataset ($n = 169$) contains a total of 16 syllabi with pronouns, 10 of which belong to HUA faculty.

4.4 Analyzing key predictors with classification trees

The descriptive statistics results in Sections 4.1–4.3 provide a better understanding of our dataset by faculty gender, rank, and field. Next, we build classification trees to identify important predictors linking to the likelihood of different Identity Safety Cues appearing on syllabi with a high degree of accuracy. Specifically, the following sections detail the results of our classification tree analysis capturing the influence of faculty demographics on the presence of pronouns (4.4.1), inclusivity statements (4.4.2), and materials written by women and gender minority authors on course syllabi (4.4.3). Additionally, we build a tree to investigate the most influential factors for syllabi to present at least one ISC, regardless of which one (Section 4.4.4). Each model's accuracy and key influencing factors are highlighted through tabled information gain values computed for each variable considered.

4.4.1 Pronouns classification tree

The classification tree in Figure 7 highlights the demographic characteristics (among faculty gender, rank, and field) with the highest influence in predicting whether a syllabus will include pronouns. (Recall that only 16 of our 169 syllabi actually include pronouns.) The first node in the tree underlines how syllabi with pronouns are likely to be written by faculty in the Humanities & Arts (HUA) department, as shown on the right branch of the diagram; this field accounts for 35 of the 169 syllabi in our dataset ($21 + 3 + 11 = 35$). The subsequent node on the right branch indicates that, among faculty from HUA, those within the instructor category are the most likely to include pronouns on their syllabi; this result matches the descriptive analysis reported in Figure 4. Finally, the leaf node on the right branch considers gender, and shows that women instructors from HUA are the most likely to have pronouns on their syllabi–7 out of 11 do. Within HUA, the second and leaf nodes show, respectively, that only three people who are not women instructors list pronouns on their syllabi; specifically, these are one man instructor and two men professors

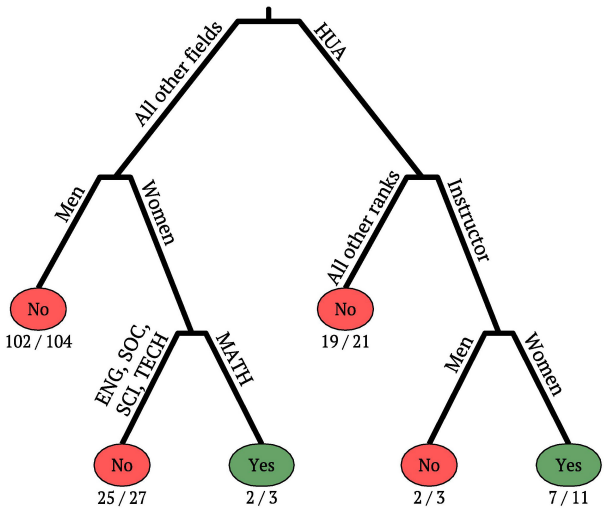

FIGURE 7
Classification tree highlighting the demographic characteristics with the highest influence in predicting whether a syllabus will include pronouns. Each gender, rank, and field is considered separately as a potential node variable rather than clustered within the three demographic axes. The tree has a high accuracy rate of 92.9%, with only 12 misclassifications out of 169 syllabi. The information gain values computed by the algorithm while selecting tree nodes and branches are reported in the second column of Table 2.

(this latter fact is not specified on the tree). Now we shift our attention to the left branch of the tree.

When considering syllabi from all other fields other than the Humanities & Arts, the most important predictive variable for the inclusion of pronouns appears to be gender. Here, most syllabi do not include pronouns (128 out of 134), but the tree shows that if a syllabus is written by a woman in Mathematical Sciences (MATH), it will likely have pronouns (2 out of 3 do). Lastly, given the absence of nodes predicting men outside of HUA to have pronouns on their syllabi, the tree shows that, in general, men are not likely to include this ISC.

The pronoun classification tree in Figure 7 has a high accuracy rate, correctly predicting outcomes 92.9% of the time, with only 12 misclassifications out of 169 syllabi. The corresponding information gain values computed by the algorithm are reported in the second column of Table 2. We note that the most important variables are the Humanities & Arts field (with the highest information gain of 7.49) along with the rank of instructor (information gain 3.64), and gender (information gain 2.92 for both women and men). Table 2 does not distinguish between positive or negative impact; it simply shows which variables have the biggest influence on the predicted outcomes. Based on the tree, however, we observe that the gender category of man negatively impacts the likelihood of producing a syllabus with pronouns. Mathematical Sciences is the next variable with the highest information gain in this tree with 2.74. We compute the information gain values for each variable shown in Table 2 by averaging the information gain computed by the algorithm every time the variable is considered for a split.

TABLE 2 Average information gain for all variables considered in Figures 7–11 trees.

Variable	Pronouns Figure 7	Inclusivity statements Figure 8	Women and gender minority authors Figure 9	Women and gender minority authors (no HUA) Figure 10	At least one ISC Figure 11
Men	2.92	8.51	4.10	2.46	13.19
Women	2.92	8.51	4.10	2.46	13.19
Professor	0.64	0.23	0.72	0.86	1.12
Ass. Prof.	0	0	0	0	0
Asst. Prof.	0	0	0	0	0
Instructor	3.64	0.69	1.53	1.64	2.60
ENG	1.47	1.91	0	0.32	0.78
HUA	7.49	6.01	7.85	-	4.45
MATH	2.74	0.08	0.80	0.07	0.95
SCI	1.01	6.87	0	0.29	2.91
SOC	0	0.56	0	0.22	1.03
TECH	1.08	1.46	4.31	2.80	3.36

The same 12 variables (first column on left) were considered in each tree and information gain scores are reported left-to-right for Figures 7–11. Only for the tree in Figure 10 (penultimate column) the HUA variable was excluded. The information gain for each variable choice is computed by subtracting the weighted entropy of each branch generated from the parent's own weighted entropy (see Supplementary material 2 for details). The values shown are the average of all these information gain scores. Higher scores correspond to higher importance in the model.

4.4.2 Inclusivity statements classification tree

The next classification tree predicts what factors influence whether a syllabus in our dataset has an inclusivity statement. Figure 8 indicates in the first node that an inclusivity statement will most likely appear on syllabi written by women faculty of any rank and field (46 of 169 syllabi fall into this grouping, right branch). The next nodes on the right flag the fields of Sciences (1st split) and Engineering (2nd split) as negative predictors of the presence of inclusivity statements on course syllabi. That is, the green leaf shows that 25 out of 30 times the tree predicts accurately that a syllabus written by a woman who is not in the Sciences or Engineering fields would have an inclusivity statement. Both singled out fields have a low number of syllabi written by women with this ISC–1 out of 12 for the Sciences and 1 out of 4 for Engineering. However, our dataset includes more syllabi from the Sciences written by women (12) compared to Engineering (4), so the former field is chosen as a node earlier in the tree compared to the latter, despite similar outcomes.

The classification tree for inclusivity statements has an accuracy rate of 78.1%. It highlights faculty's gender and field as the most influential features for accurate predictions, with both chosen as nodes. We report the information gain values for this tree in the third column of Table 2. The highest information gain belongs to gender (with 8.51) followed by the Sciences (with 6.87). While the men and women variables always show the same score due to their binary nature, here we note that (once again) the men variable negatively impacts the chance of having inclusivity statements on syllabi, since 93 of 123 syllabi in our dataset written by men did not have inclusivity statements (left branch). Note how the left branch of the tree stops after the first split and does not generate any further nodes; this is because the algorithm cannot find a variable (with each potential branch including a minimum of 3 syllabi) that generates a high enough information gain to warrant a split.

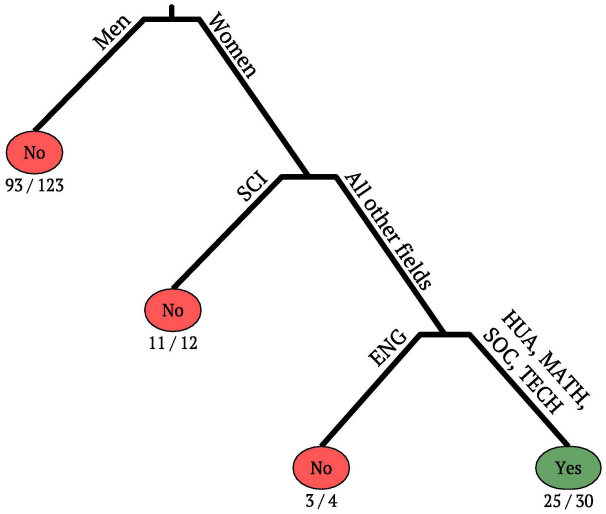

FIGURE 8
Classification tree highlighting the demographic characteristics with the highest influence in predicting whether a syllabus will have inclusivity statements. Each gender, rank, and field is considered separately as a potential node variable rather than clustered within the three demographic axes. The tree has an accuracy rate of 78.1%. The information gain values computed by the algorithm while selecting tree nodes and branches are reported in the third column of Table 2.

Despite not being chosen as a node in the tree, Table 2 shows the Humanities & Arts field with the third highest information gain (6.01). This is likely because HUA was one of the options identified from the tree as a viable first-split variable; inherently, the first split always generates the highest information gain (since

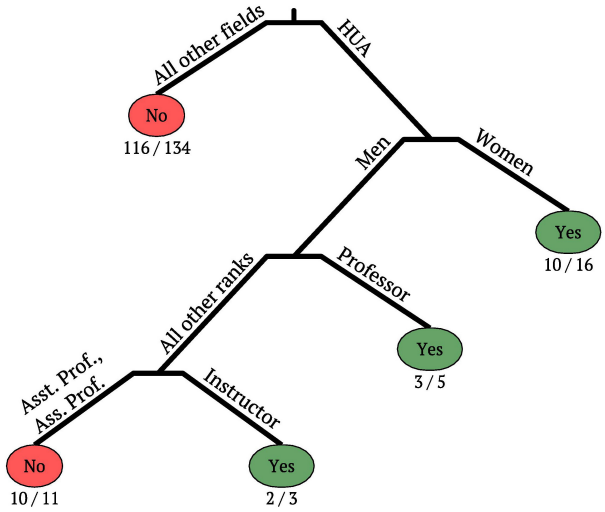

FIGURE 9
Classification tree highlighting the demographic characteristics with the highest influence in predicting whether a syllabus will include course materials written by women and gender minority authors. Each gender, rank, and field is considered separately as a potential node variable rather than clustered within the three demographic axes. The tree has a high accuracy rate of 83.4%. The information gain values computed by the algorithm while selecting tree nodes and branches are reported in the fourth column of Table 2.

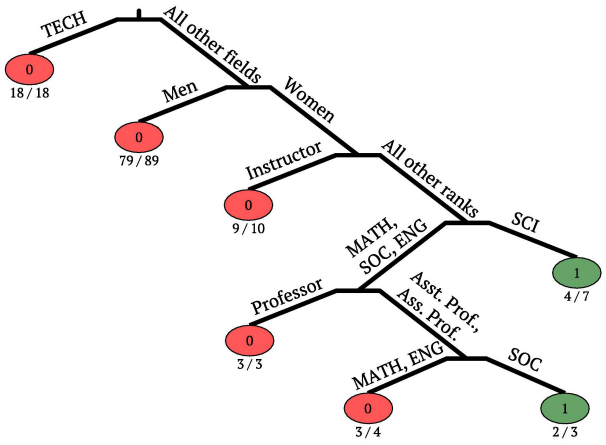

FIGURE 10
Classification tree highlighting the demographic characteristics with the highest influence in predicting whether a syllabus will have materials written by women and gender minority authors when excluding course syllabi from the Humanities & Arts (HUA). Each gender, rank, and field (other than HUA) is considered separately as a potential node variable rather than clustered within the three demographic axes. The tree has a high accuracy rate of 88.1%. The information gain values computed by the algorithm while selecting tree nodes and branches are reported in the fifth column of Table 2.

without any splits, there would be no tree) likely influencing the average information gain value for HUA. We note that had HUA been chosen first, it would have positively affected the tree's overall outcome given its high proportion of syllabi with inclusivity statements (22 of 35 include them, see Figure 6B).

4.4.3 Materials written by women and gender minority authors classification tree

In predicting the factors influencing the presence of materials written by women and gender minority authors on syllabi, the classification tree in Figure 9 again identifies the Humanities & Arts (HUA) field as the first node. The next spilt occurs within the HUA branch on the right based on the gender variables. Women in HUA are predicted to include gender minority authors on their syllabi more often compared to men (10 out of 16 syllabi written by women do vs. 11 out of 19 created by men). Interestingly, when we look to the left branch of the gender split within HUA, we see a further breakdown within the men category based on faculty rank. According to the tree, men HUA faculty with the professor rank are the most likely to include gender minority authors on their syllabi, followed by those with the rank of instructor. In other words, women faculty from HUA (regardless of rank), men professors in HUA, and men instructors in HUA are the groups who are predicted to most frequently include materials written by women and gender minority authors on their syllabi.

The fourth column in Table 2 reveals that the highest information gain is associated with the Humanities & Arts variable (7.85), followed by technology (4.31), and then the gender variables (both with 4.10). The model demonstrates a high predictability rate with an accuracy of 83.4%. Since only the HUA side of the tree proceeds with further splits, the TECH variable does not come into play as a possible node despite its high associated information gain; similarly, MATH (with 0.80) is also not considered. Hence, rank variables such as instructor (1.53) and professor (0.72) are the next to be chosen by the tree algorithm.

As mentioned, the tree positively predicts syllabi with materials written by women and gender minority authors for HUA syllabi and stops splitting after the first branch for all other fields, despite the large number of syllabi in this grouping (134 of 169). Hence, we built a separate tree for the same ISC but excluding HUA syllabi (Figure 10), to better predict which factors influence usage of materials written by women and gender minority authors among all other variables.

After removing the HUA variable from the classification algorithm, there was a decrease in information gain across the tree, see the penultimate column in Table 2. Previously, HUA had the highest information gain at 7.85 (greater by over 3 points compared to the second highest score) which confirms it as the algorithm's best possible choice as the initial node in Figure 9. Without HUA, there is no clear variable dominating the tree, but rather the information gain values equilibrate across possible variable choices. The same four variables appear to be the most important factors when considering the presence of materials written by women and gender minority authors on syllabi: TECH (2.80), the gender variables (2.46), and the instructor rank (1.64). While the information gain for TECH and the gender variables reduced once HUA was excluded, it increased for the rank variables of instructors (1.53 to 1.64) and professors (0.72 to 0.86). This underlines how in non-HUA fields faculty rank is more important than in HUA when considering the presence of this ISC on syllabi

(see Figure 10). Very few non-HUA syllabi in our dataset include materials written by women and gender minority authors (only 18 out of 169 – 35 = 134), but excluding HUA from the tree increases the overall prediction accuracy to 88.1%.

4.4.4 At least one ISC classification tree

This final tree in Figure 11 considered all three Identity Safety Cues discussed in this paper to see which factors influenced the likelihood of at least one of them being used on a syllabus. The first node in the classification tree happens along the gender line, separating women from men. This is not surprising given that most of the trees when considering one of our three ISCs of interest at a time, included women as an important factor in the model; 46 of the 169 syllabi in our dataset were provided by women faculty (right branch) and 123 by men (left branch). The next two nodes on the right branch split along field lines: first separating women faculty in the Humanities & Arts (HUA) from all others, and then further isolating women faculty in the Sciences (SCI). If a woman is in HUA, they are predicted to have at least one ISC on their syllabus 16 out of 16 times. Women faculty not from the Sciences, are also very likely to include at least one ISC on their syllabi, 14 out of 18 times. In other words, women from Humanities & Arts, as well as Engineering, Mathematical Sciences, Technology, and the Social Sciences are far more likely to have at least one ISC compared to women in the Sciences. However, when comparing faculty in the Sciences by gender, women do much better than men by including at least one ISC 5 out of 12 times, compared to 3 out of 20 times. The last node on the right branch is based on faculty rank. It appears that women faculty in the Sciences with all ranks other than instructor, are more likely to have at least one ISC (5 out of 7 times). To rephrase it, a woman faculty with the rank of professor, associate professor, or assistant professor in the Sciences, is more likely to have at least one ISC compared to women instructors in the same field (here, 5 out of 5 syllabi do not include any ISC).

On the left branch, the tree portrays the factors influencing how men faculty in our dataset use ISCs. Overall, being a man has a negative impact on the use of ISCs (83 out of 123 syllabi written by men do not include any ISC), but some fields and ranks use ISCs more frequently than others. The classification tree predicts that a man faculty in the Technology or Sciences disciplines is the least likely to have any ISCs on their syllabi (with 14 out of 15 and 17 out 20 syllabi with no ISCs for these two fields, respectively). Comparatively, men faculty who are professors from HUA are the most likely to have at least one ISC (5 out of 5 syllabi do). Men with the rank of instructor in HUA are the next group predicted to have at least one ISC on their syllabus (3 out of 3 syllabi do). The percentage of correct predictions for this classification tree was 77.5%. This is the only tree we produced that includes pure nodes; these are nodes with zero weighted entropy (equation (SM1) in Supplementary material 2). There are three pure nodes in Figure 11: women faculty in HUA (16/16), men professors in HUA (5/5), and men instructors in HUA (3/3).

We report Figure 11's information gain values in the last column of Table 2. Faculty gender is identified as the most influential factor for a syllabus to have at least one ISC (with an unprecedented double-digit information gain of 13.19). Similarly to earlier trees, being a woman faculty tends to have a positive impact while being a man faculty generally has a negative impact on the model. The next highest values belong to the fields of Humanities & Arts (4.45), Technology (3.36), and the Sciences (2.91). Regardless of their gender, faculty in the Humanities & Arts are predicted to likely include at least one ISC on their syllabi. In fact, the underlying numbers show that 27 of 35 HUA syllabi have at least one ISC and the three pure nodes in the tree all represent HUA faculty. Across both sides of the tree, the Sciences category has a negative impact on having at least one ISC on syllabi. The tree predicts that for both women and men faculty in the Sciences no ISCs would likely appear on a syllabus (24 of 32 SCI syllabi have no ISC). Finally, the influence of the instructor variable (2.60) is nuanced: it appears to have a positive impact for men in HUA but a negative impact for faculty in every other academic field (regardless of gender).

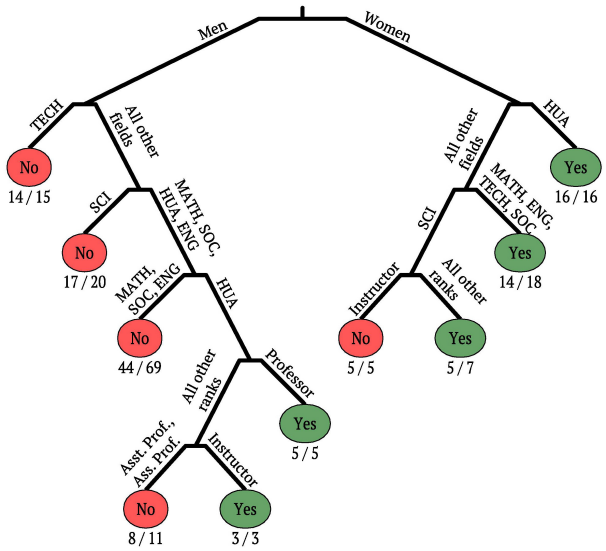

FIGURE 11
Classification tree highlighting the demographic characteristics with the highest influence in predicting whether a syllabus will include *at least one* Identity Safety Cue. Each gender, rank, and field is considered separately as a potential node variable rather than clustered within the three demographic axes. The tree has an accuracy rate of 77.5%. The information gain values computed by the algorithm while selecting tree nodes and branches are reported in the last column of Table 2.

The classification tree analysis across Section 4.4 provided an understanding of the predictors influencing the use of our three ISCs of choice in course syllabi: pronouns, inclusivity statements, and materials written by women and gender minority authors. Key variables such as faculty gender, rank, and field all developed in the model as significant factors. Women faculty with any rank and from any field along with faculty in the Humanities & Arts (regardless of gender), consistently showed a higher likelihood of including ISCs, particularly pronouns and course materials written by women and gender minority authors. Conversely, faculty who are men, especially those in the Technology, Sciences, Engineering, and Social Sciences fields, were less likely to include any ISCs on their syllabi. The predictive models demonstrated high accuracy rates for each tree, showcasing the impact of gender and field on inclusive teaching practices.

5 Discussion

Syllabi are an important tool for signaling faculty commitment to inclusive teaching practices and creating a welcoming classroom environment. The results suggest that gender and field influence course syllabi design the most, with women and faculty of all ranks in the Humanities & Arts (HUA) using the three Identity Safety Cues (ISCs) selected more often than all other groups. The following sections address the potential underlying reasons why there are disparities between groups and offer strategies for broadening the implementation of inclusive pedagogy.

Women faculty are significantly more likely to include ISCs in their syllabi compared to men. Only 23.9% of syllabi authored by women lacked ISCs, while 67.5% of syllabi from men did not include any. Furthermore, 17.4% of syllabi by women faculty included all three ISCs (pronouns, inclusivity statements, and materials authored by women or gender minorities), while only 0.8% of men's syllabi did. Men and those outside of the Humanities & Arts disciplines recorded the least ISCs. Women in STEM also tend to incorporate content by gender minority authors more frequently, contributing to more inclusive classroom environments. These findings suggest a strong connection between faculty gender and the prioritization of inclusive practices in syllabi design.

5.1 The impact of gender on the use of Identity Safety Cues

Women in academia, especially in STEM fields, have historically faced significant challenges and discrimination due to stereotypes and implicit biases especially in the areas of compensation, recognition for scholarly work, and institutional dynamics (Charlesworth and Banaji, 2019; Gruber et al., 2020; Casad et al., 2021). Because so many women faculty personally experienced discrimination (Kube et al., 2024), they could be particularly motivated to create inclusive classroom environments where all students feel supported and valued (Darchuck, 2024). By including ISCs on their syllabi, women may be trying to explicitly signal that their courses are safe spaces for students from historically marginalized groups.

Women faculty participate in service activities at higher rates than their male colleagues, often carrying out service responsibilities tied to their identities such as gender, race, and sexual orientation (Guarino and Borden, 2017; Mitchell and Hesli, 2013; Porter, 2007; Pyke, 2011; Joseph and Hirshfield, 2011; Gruber et al., 2020). As part of these service activities, women may participate in communities of practice, professional development trainings, and mentoring programs (Ortiz-Martínez et al., 2023, p. 12). The exposure to these opportunities could translate into gaining skills in inclusive pedagogical practices. For example, a woman of color computational physicist might be approached to participate in developing curricula for marginalized students who are beginning their 1st-year majoring in physics at her institution. This is outside of her field of expertise, but on this committee, she learns pedagogical strategies that facilitate inclusivity in the classroom and may choose to implement them in her own teaching and syllabi design.

Another important consideration that arises from our analysis is that women faculty in STEM fields tend to use content produced by women and gender minority authors more frequently than their men counterparts. Other studies such as Harris et al. (2020) produced similar results showing that female faculty in STEM subjects used materials written by women authors more often in their courses (p. 7). This is notable because, despite there being limited books and scholarship authored by women and gender minority authors in STEM (Xiang et al., 2024; Wood et al., 2020; Simpson et al., 2021; Becker and Nilsson, 2021; Pienta and Smith, 2012), women STEM faculty are seeking to integrate authors' gender diversity into their curriculum (Harris et al., 2020). This practice is often more challenging in STEM classrooms compared to the Humanities and Social Sciences because of the prevailing belief that STEM subjects are purely objective and therefore the gender of textbooks' authors does not matter (Bowen, 2021).

However, research shows that even in STEM subjects, objectivity is relative because instructors and researchers are people carrying their own biases which impact their teaching practices (Kube et al., 2024). Any research question inherently carries some bias because focusing on one question means others are left out. Additionally, the meaning of research results can vary depending on who is interpreting them (Jasanoff, 2009, p. 269). Furthermore, STEM textbooks often use examples only involving male characters and focused on traditionally male activities, thus perpetuating biases, stereotypes, and the dominant narrative that only men belong in STEM (O'Leary et al., 2020; Kuchynka et al., 2022; Harbin et al., 2019).

In summary, syllabi signal faculty commitment to inclusive teaching practices. Our findings suggest that both gender and academic field significantly influence the use of ISCs in course syllabi. Notably, men and faculty in non-HUA fields consistently show lower implementation rates, indicating substantial room for growth in creating welcoming academic spaces for students. The following section explores the role of faculty's fields of study in greater depth, highlighting how the Humanities & Arts disciplines play a pivotal role in promoting inclusivity with their use of Identity Safety Cues.

5.2 Field influence on the inclusion of Identity Safety Cues

Our study revealed that faculty in the Humanities & Arts (HUA) at WPI, regardless of gender and rank, are most likely to include at least one Identity Safety Cue (ISC) on their syllabi; approximately 77% of them do (27 of 35), as shown in Figures 5, 6B, and 10. Only 16 of the 169 syllabi in our dataset contain pronouns; 10 of these are for HUA courses (62.5%, Figures 5, 6B, and 7). Inclusivity statements are the only ISC that appears in at least one syllabus in each field (Figures 5 and 8). Yet, once again, HUA is the field that counts the most syllabi with inclusivity statements, with 22 out of 57 syllabi (about 39%, Figures 5 and 6B). Thirty-four syllabi in our dataset contain materials written by women

and gender minority authors, 16 of which are HUA syllabi (47%, Figures 5, 6B, and 9).

Interestingly, men in HUA are more likely to incorporate at least one ISC on their course syllabi compared to men in all other disciplines (Figure 11). Also, women and men with the rank of instructor and men with the rank of professor are the most likely groups to incorporate materials written by women and gender minority authors in their courses (Figure 9). The changing composition of faculty bodies toward a smaller number of tenure-track positions has led to an increase in instructors hired in contingent roles (Spinrad and Relles, 2022; Maxey and Kezar, 2015). As such, instructors may be more flexible in their syllabi design and more open to incorporating less traditional course materials to engage students and stay relevant in their fields as they look for permanent positions. Instructors may also be more up to date on current trends in academia and society as they often are hired after recently completing graduate school. Finally, research indicates that students hope for more inclusive classroom environments regardless of their major and gender (Bernardi et al., 2024); faculty at the instructor rank might try to shape their courses to be more inclusive to receive positive course evaluations and remain competitive in their contingent positions.

Thanks to their seniority and established positions, men professors might feel more comfortable introducing diverse perspectives without fear of repercussions. Tierney and Bensimon (1996) discuss how tenure can provide the security needed for faculty to pursue diverse and potentially controversial academic interests. This may extend to non-traditional teaching practices: tenure provides the academic freedom to explore and promote a wider range of scholarship in one's course.

Generally, faculty in HUA disciplines such as literature, gender studies, history, Africana studies, art, philosophy, etc. are often more attuned to the importance of including diverse perspectives and challenging dominant narratives compared to those in STEM (Sensoy and DiAngelo, 2017, p. 6). Additionally, HUA disciplines often have more readily available course materials produced by women and gender minority authors compared to STEM, making it easier for all faculty to incorporate such scholarship into their course materials (Phillips, 2024; Kuchynka et al., 2022). Lastly, faculty in HUA fields often share a commitment to social justice and equity, which promotes the inclusion of a wider spectrum of voices in their courses (Gannon, 2020).

Removing HUA as a variable when considering the inclusion of materials written by women and gender minority authors on syllabi (Figure 10) allowed us to better understand the mechanisms at play in other fields. In STEM and the Social Sciences, where gender minority authored texts are less frequently utilized, faculty gender and rank emerged as important predictors of who would employ these course resources. As previously mentioned, senior faculty may have more autonomy or resources to incorporate diverse materials in their courses. Instructors who are not on the tenure track may have less at stake when including a variety of authors, even in fields where such scholarship is less prevalent. Overall, women faculty in STEM select materials written by women and gender minority authors for their syllabi more often than men do. The findings point to structural differences between the Humanities and other fields, highlighting how STEM and Social Science disciplines may need more targeted efforts to increase the representation of gender minority authors in course content.

When focusing on the use of Identity Safety Cues in STEM and the Social Sciences, our study identifies general trends and some differences in how inclusive practices are adopted across fields. It seems that, overall, being in a STEM field has a significant negative impact on the likelihood of having any ISCs on course syllabi. When considering the presence of at least one ISC, the best performing STEM field is Engineering where 12 of 24 syllabi spanning four Engineering (ENG) disciplines, each have exactly one ISC. However, no ENG syllabi have pronouns and none present more than one ISC. When taking a closer look to more granular results, faculty gender and field together often work as a guiding force toward the inclusion (or exclusion) of ISCs on syllabi while rank is a less influential factor. For example, women faculty in the field of Mathematical Sciences at WPI are more likely to include pronouns on their syllabi compared to women in all other STEM and Social Sciences fields (Figure 7). While encouraging to see, the sample size for this specific subgroup is quite small (only 3 of the 38 MATH syllabi in our dataset were written by women, and 2 of 3 include pronouns) so making general statements is challenging. This unusual result may be due to the changing culture in Mathematical Sciences at WPI, the personal commitment to inclusivity of specific faculty, or the influence of gender diversity initiatives within the mathematics community at large.

This happens again when considering the TECH field (i.e., Computer Science and Data Science). In general, TECH includes the smallest number of ISCs: only 3 out of 18 syllabi have inclusivity statements while no pronouns or materials written by women and gender minority authors are used. This is visible, for example, in Figure 11 where on the left side of the tree, TECH is the first branch to split off and 14 of 15 syllabi written by men are predicted not to include any ISCs. In contrast, women in TECH do much better, with 2 out of 3 syllabi including at least one ISC (this fact is not explicitly reported in the tree since TECH appears in aggregate with other fields on the right side of the tree).

Our analysis further indicates that faculty in the Social Sciences include ISCs on their syllabi much less often than faculty in the Humanities & Arts (Figure 5). Considering the gender parity in baccalaureate as well as doctoral degrees awarded in the Social Sciences in the U.S.A. (Casad et al., 2021), one would expect these disciplines to have high ISC usage on syllabi given the demonstrated strong influence of gender on inclusivity. However, while some subjects like psychology and sociology have more than 50% women graduates (over 70% for psychology), others, such as economics, business, and political science, have significant underrepresentation of women among doctoral degree recipients and faculty (Gruber et al., 2020; Casad et al., 2021; Lundberg and Stearns, 2019).

All students at WPI must take six courses in the Humanities & Arts to graduate (Cohen, 1977); 27 of the 35 HUA syllabi in our dataset contain at least one ISC, which shows that many of our students are being exposed to at least some equity-focused pedagogical practices in those classes. Nonetheless, more STEM and Social Sciences faculty should be incorporating ISCs in their courses to help create a welcoming environment for all students that extends beyond the Humanities & Arts disciplines.

The infrequent use of ISCs in most fields is in sharp contrast with students' needs and expectations (Bernardi et al., 2024). We underline the importance of taking an inclusive approach in syllabi design across all disciplines, starting with a more widespread inclusion of pronouns, materials written by women and gender minority authors, and inclusivity statements. The implications of these findings lie in the need to promote equity and inclusion in STEM education. STEM fields have traditionally been less open to change, not inclusive of people's lived experiences, and intolerant toward differences, often perpetuating environments that marginalize underrepresented groups. Studies show that building a supportive environment in STEM courses for all students is beneficial for everyone, but can have a particularly positive impact on those from historically marginalized groups, such as women and people of color, who typically have higher attrition rates (Hughes, 2018; Funk and Parker, 2018; Stout and Wright, 2016; Chang et al., 2014; Ashford et al., 2017; Maimon et al., 2021; Savaria and Monteiro, 2017). Using Identity Safety Cues in STEM courses can help break down barriers that might prevent students from fully engaging in their education.

6 Conclusion

Higher education institutions should encourage all faculty, regardless of gender, rank, race, or discipline, to incorporate Identity Safety Cues (ISCs) and inclusive teaching strategies into their courses. A good way to promote these practices may be to provide incentivized professional development training for faculty on inclusive teaching. It is particularly important to design these training sessions to address the needs and concerns of men and STEM faculty participants, who, as our work indicates, may require additional support to adopt the use of Identity Safety Cues and other inclusive pedagogy tools. A targeted intervention involving professional development and mentorship could help promote pedagogical shifts toward greater inclusivity in STEM education.

Research shows that with proper training and support, men can become proponents of inclusivity in their university classrooms (Emmers et al., 2020; Llorent and Alamo, 2016). To facilitate implementation, institutions could pair experienced men faculty who use inclusive teaching methods (likely from the Humanities & Arts) with men colleagues in other disciplines to create a collaborative environment where mutual learning and support are prioritized. The same strategy could be applied to women faculty in STEM subjects. This mentorship structure may help faculty gain confidence in genuinely employing ISCs and other inclusive strategies in their classrooms to improve their teaching practices. Lastly, faculty who promote inclusivity in their classrooms could be celebrated and recognized with teaching awards from the university. By rewarding these efforts, institutions can create a culture where inclusive teaching is valued and seen as a key component of professional success.

Institutions play an important role in facilitating this shift toward inclusive pedagogy by providing professional development programs, establishing mentorship and support networks, recognizing and rewarding inclusive teaching efforts, developing clear policies, and conducting internal assessments on existing teaching practices. By implementing these strategies, universities can foster a more inclusive classroom environment and facilitate change toward inclusivity in higher education.

6.1 Limitations of the study

While this study provides valuable insights into the use of Identity Safety Cues (ISCs) in university syllabi, some limitations must be acknowledged. First, the dataset contains 169 syllabi exclusively from Worcester Polytechnic Institute. This may limit the generalizability of the findings to other universities that are not STEM-focused or that have different faculty demographics. Second, the study relies on the analysis of syllabi which may not fully capture the inclusive practices faculty employ in their classes. For example, instructors may use groundbreakingly inclusive strategies in their teaching without mentioning them in their syllabi. Third, we consider the inclusion of three specific ISCs—pronouns, inclusivity statements, and course materials written by women and gender minority authors—as indicators of inclusive teaching practices. Although these aspects of course syllabi are important to students and signal the inclusivity of a faculty's teaching approach, there are many other possible markers for inclusivity we are not considering. Fourth, there is a potential for bias in the self-selection of syllabi submitted to the study. Instructors who are more aware of and committed to inclusivity may be more likely to submit their syllabi for analysis, potentially skewing the results. Finally, the study does not account for the varying levels of training and support faculty receive in implementing inclusive practices, which could influence the use of ISCs. Nonetheless, this study provides valuable insights into inclusivity at a STEM university.

Data availability statement

The datasets presented in this article are not readily available because the syllabi were collected under the condition of anonymity; sharing the syllabi dataset would compromise the privacy of faculty authors. Requests to access the datasets should be directed to Francesca Bernardi, fbernardi@wpi.edu.

Author contributions

AC: Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualization, Writing – review & editing. CB: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing – original draft, Writing – review & editing. FB: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

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