

## RESEARCH ARTICLE

## Examining Underrepresented Minority STEM Faculty Members' Motivation for Research

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### Abstract

Underrepresented minority (URM) university faculty can be identified as those whose representation based on gender, race, and/or ethnicity in particular fields, such as Science, Technology, Engineering, and Math (STEM), are smaller than in the US population. Studies on URM faculty have found discrimination and affiliated stress impact faculty in many aspects of their work, such as performance in research. In the current study, we examined STEM faculty who self-identify as URM, their experiences of workplace discrimination, and how these encounters affect their self-determined motivation to conduct research. Six-hundred and fifty-one faculty from 10 US institutions completed an online survey. Of the participants, 37.5% self-identified as URM, of which 81% were women, 20% non-white, and 6% Hispanic/Latinx ethnicity; notably, the data shows that 24% of women and 56% of non-white faculty did not self-identify as URM. More than 87% of URM reported workplace bias, which correlated with significantly lower autonomy and relatedness with coworkers. URM women reported gender discrimination at work was common and upsetting, which related to greater amotivation. Non-white and Hispanic/Latinx/Spanish URM who reported high success in research also cited more discrimination. URM faculty motivation was fostered by autonomy and competence, and much more by relatedness compared to non-URM faculty. For non-URM, autonomous motivation (enjoyment, value) positively related to research success, whereas for URM faculty a lack of introjected motivation (guilt) was the strongest predictor. Discussion focuses on implications for future studies of faculty motivation and strategies to promote URM faculty research productivity.

### Keywords

Underrepresented Minority, STEM, Faculty, Motivation, Research, Discrimination

### Introduction

Underrepresented minority (URM) individuals are defined as those whose representation are smaller than in the US population, typically based on gender, race, and/or ethnicity. Among university faculty URMs are particularly visible in the fields of Science, Technology, Engineering, and Math (STEM) (National Science Foundation, National Center for Science and Engineering Statistics, 2020). Results from empirical studies reveal URM university faculty experience biases, discrimination, and affiliated stress that can impact multiple aspects of their work such as research performance (Fisher *et al.*, 2019; O'Meara *et al.*, 2020; Stolzenberg *et al.*, 2019; Stupnisky *et al.*, 2015). URM faculty workplace discrimination could further manifest itself in depression, isolation, and lessened relatedness to colleagues (Zambrana *et al.*, 2017; 2021), which may affect their motivation to conduct research. A growing body of empirical studies has found motivation to be critical to faculty success in teaching (Stupnisky *et al.*, 2018; Colbeck *et al.*, 2002) and research (Lechuga, 2012a; Daumiller *et al.*, 2020). URM faculty motivation, and specifically to conduct research, may be uniquely impacted by any workplace discrimination they experience, yet this has rarely been studied. URM faculty reported spending more time teaching, mentoring, and advising, and less time on research which could be an indicator of

motivation (O'Meara *et al.*, 2020). The purpose of this study was to examine which STEM faculty self-identify as URM, their experiences of workplace discrimination, and how these encounters affect their self-determined motivation to conduct research.

## URM Faculty

URM faculty face unique challenges in higher education. Regarding gender, fewer women are employed as faculty in STEM fields than men (Carrigan *et al.*, 2011). Research studies, including Beaudry & Larivière (2016) and Larivière *et al.* (2013), reveal a pattern where women, on average, produce fewer scholarly publications, receive fewer citations for their work, and secure less research funding compared to their male counterparts. Additionally, the impact of family dynamics on research productivity is evidenced by the work of Hunter and Leahey (2010), indicating that women often experience a decline in research output and visibility after becoming parents.

The academic environment further contributes to gender inequalities. Kaminski and Geisler (2012) and Hill *et al.* (2010) highlight that women are more likely to leave academia due to unfavorable workplace atmospheres, which may include limited support systems or discriminatory practices. Contrastingly, men's primary reason for leaving academia appears to be related to monetary factors. In line with these findings, Stupnisky *et al.* (2015) found significant differences between men and women faculty in terms of clear expectations, balance, and collegiality. Notably, new female faculty members experience lower satisfaction with their treatment by their senior faculty, compared to their male peers. Overall, research has shown that numerous factors, from personal choices to institutional barriers, can limit women's participation and success in STEM fields (Ceci & Williams, 2009, Kaminski & Geisler, 2012).

Regarding race and ethnicity, an analysis of over 4,000 tenure-track faculty from 40 public institutions (2015-16 AY) found black faculty accounted for just 0.7-2.9 percent and Hispanic faculty 2.5-5.1 percent of all faculty in biology, chemistry, and economics (Li & Koedel, 2017). A national study explored, despite a high number of applications submitted, African American and Black PIs were awarded fewer grants from the National Institute of Health than non-URM counterparts (Lauer, 2021). Faculty of color, compared to white faculty, had a lower publication record with respect to journal articles and books, yet a higher commitment to research activities (Antonio, 2002). Considering discrimination aspects, African American and Asian/Pacific Islander faculty members were found to be less satisfied with their collegial relationships compared to white faculty (Ponjuan *et al.*, 2011).

Intersectional studies that considered gender, race, and/or ethnicity revealed STEM disciplines can be particularly challenging for URM faculty. In their analysis of the successful transition of URM and women Ph.D. students to the professoriate in STEM programs, some of the underlying academic culture could lead to gender, race, and ethnic-based disparities (Fisher *et al.*, 2019); in addition to the normal workplace stresses, women of color endure have to endure extra strain stemming from the presence of sexism and racism (Wilkins, 2017). Moreover, gender and racial stereotypes negatively impact the selection of minority candidates and limit their chances of getting accepted in STEM post-doctoral opportunities (Ethan *et al.*, 2019). Finally, stresses related to microaggression are more prevalent among URM STEM faculty compare to non-URMs (O'Meara *et al.*, 2020). These studies indicate URM faculty are susceptible to unique challenges, yet the motivation of URM faculty and its relationship to productivity, specifically for research, has yet to be sufficiently studied.

## Motivation for Research

A leading perspective on motivation, self-determination theory (SDT; Deci & Ryan, 1985; Deci *et al.*, 1997) suggests the degree to which three basic psychological needs are satisfied will determine motivation: autonomy (freedom to choose), competence (perceived expertise or skill), and relatedness (feeling connected with others). If individual's needs are supported for a particular task, in this case research, they will experience optimal autonomous motivation (task engagement because it is enjoyable [intrinsic] and/or valuable [identified]) and are more likely to produce scholarly work. Not all faculty are ideally motivated though, as external influences such as funding to conduct research, annual evaluations, submission deadlines, and difficult interactions with students and colleagues can lead to controlled motivation (task performance to prevent guilt or anxiety [introjected] and/or to gain rewards or avoid punishment [external]) and lower productivity. The worst psychological state for productivity, amotivation, is a total absence of task engagement. A critical assertion of SDT is

that the type of motivation is more important than the quantity of motivation in predicting outcomes (Deci & Ryan, 2008).

There is growing empirical evidence of the important relationship between faculty motivation and research success (Stupnisky *et al.*, 2017; 2019). A survey of 781 faculty members from 28 US institutions found intrinsic motivation for research had a significant positive relationship with perceived value of conducting research, which in turn predicted research effort and productivity (Hardré *et al.*, 2011).

In an study conducted by Stupnisky *et al.* (2017), involving 105 pre-tenure faculty members from two Midwestern doctoral US universities, it was observed that faculty members whose basic psychological needs of autonomy and competence were fulfilled were more likely to report higher levels of intrinsic motivation and perceived success in research. This implies that when faculty members feel a sense of control over their work and believe in their ability to achieve their research goals, they are more driven to engage in research activities and experience a sense of accomplishment. Building upon this idea, Stupnisky *et al.* (2019) expanded the scope of their investigation to 1846 US faculty across 19 US institutions. They reaffirmed the significance of autonomy and competence in predicting autonomous motivation among faculty members. Moreover, autonomous motivation was found to mediate the relationship between faculty members' psychological needs satisfaction and their self-reported research productivity. Interestingly, external rewards and introjected motivation (motivation driven by guilt or external pressures) did not show a substantial connection with research success, highlighting the distinct role of intrinsic motivation in academic achievement.

In parallel, a study concerning 173 teacher education faculty in Pakistan (Angaiz *et al.*, 2021) yielded analogous conclusions. Here, intrinsic motivation, coupled with effective work habits, research knowledge, and skills in research, emerged as pivotal contributors to research productivity. Notably, extrinsic motivation and socialization exhibited negligible links to productivity, reiterating the dominance of internal factors.

#### **URM Motivation for Research**

The influence of motivation on the research success of underrepresented minority (URM) faculty has primarily been examined through the lens of gender differences, with a lesser focus on the application of Self-Determination Theory (SDT). Several studies have explored this connection, revealing various insights.

In the earlier study by Wiley *et al.* (1979), which applied attribution theory to editorial decisions and publication outcomes involving 233 faculty members, it was discovered that irrespective of the outcome, women tended to attribute relatively more importance to uncontrollable causes compared to men. This indicates a potential gender-based variation in how attribution and motivation intersect within the context of research publication decisions. Similarly, in a study involving 337 academics from major Australian universities (Schoen & Winocur, 1988), a gender-related disparity in confidence emerged. Female academics exhibited lower confidence in research tasks compared to teaching and administrative duties, while male academics displayed equal confidence in performing both research and administrative tasks. This underscores a gender-related variance in perceived competence across different academic responsibilities.

Delving further into the gender dynamic, Landino and Owen (1988) investigated departments at a large New England university and observed that departments with higher percentages of female full-time faculty had lower research self-efficacy on average per faculty member when compared to departments with a greater proportion of male faculty. In a parallel vein, research by Vasil (1992) involving 240 university faculty from a large southern US university found that male faculty members reported significantly stronger research self-efficacy beliefs, devoted more time to research activities, and achieved higher research productivity compared to their female counterparts. Interestingly, within the Iranian university context, Shavaran *et al.* (2012) discovered no distinguishable differences in research self-efficacy between male and female faculty members among 261 participants. This suggests that the connection between gender and research self-efficacy can be context-dependent and influenced by cultural and institutional factors.

The application of Self-Determination Theory (SDT) to understanding motivation among faculty members reveals intriguing insights, as evidenced by the two following studies. In their study involving 337 faculty members in STEM disciplines across Canadian and American colleges and universities, Deemer *et al.* (2012) employed SDT to examine differences in factor loadings related to failure avoidance and extrinsic rewards. Their

findings suggest that men and women in the STEM fields are influenced by distinct extrinsic and avoidance factors. This underscores the significance of considering gender-specific motivations within the context of extrinsic rewards and the desire to avoid failure. Similarly, Stupnisky *et al.* (2019) contributed to this understanding by exploring the gender-based dynamics in motivation among faculty members. Their research revealed that male faculty, when compared to their female counterparts, reported higher levels of research autonomy and perceived success. Moreover, racial differences were also noted; white faculty members exhibited greater autonomous motivation and perceived research success, relative to non-white faculty, but also demonstrated higher levels of introjected and external motivation. This implies that intrinsic motivation and self-perceived success might be more pronounced among male and white faculty members, while external and internal pressures might differ across gender and racial lines.

The research landscape presented certain limitations in the studies discussed. These studies primarily focused on comparing average levels of motivation and its connections to research success among various groups, yet they didn't thoroughly explore if these associations varied for URM faculty. Barnett *et al.* (1998) contributed to this area by investigating a larger sample of faculty members from 24 medical schools in the US. They delved into the associations between intrinsic motivation, extrinsic career motivation, and research success among a diverse group of 1,764 faculty members. Interestingly, they found that intrinsic motivation had a positive relationship with publications, while extrinsic career motivation had a negative association. Crucially, these associations held consistently across genders, indicating that the impact of these motivational factors on research success was not influenced by gender.

Given the unique circumstances and challenges URM faculty might face, there's an imperative need for further investigation in this area. Understanding how motivation interacts with productivity in research within the context of URM faculty can provide valuable insights into fostering equitable and supportive environments that cater to the diverse motivational needs of faculty members from underrepresented backgrounds. In essence, while existing studies offer valuable perspectives, the relationship between motivation and research success for URM faculty remains an area deserving of more comprehensive exploration.

## Current Study

The overarching objective of this study was to evaluate how URM status relates to faculty motivation to conduct research and perceived research success. The major research questions of this study were:

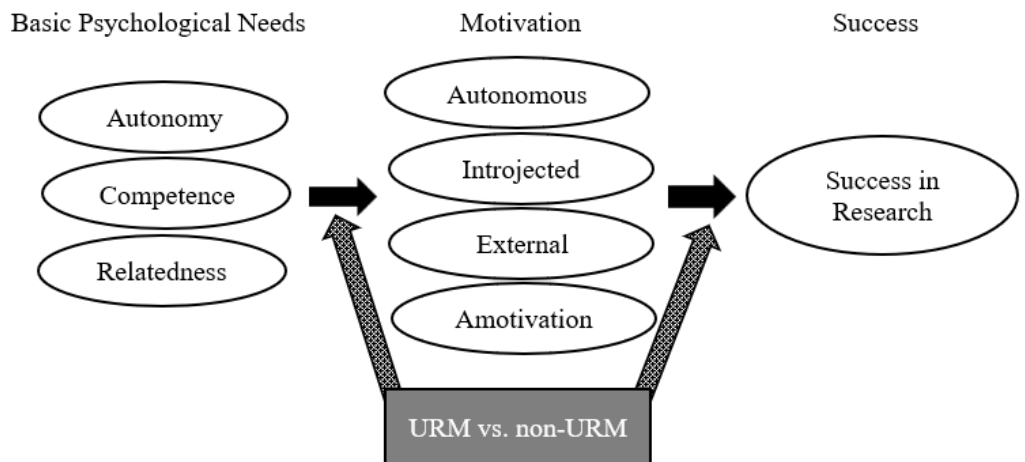
1. Who self-identifies as an underrepresented minority faculty?
2. Among URM, what level of discrimination do they self-report?
3. What level of motivation and success do URM faculty report, and how do these compare to non-URM faculty?
4. Is the level of discrimination (gender, race/ethnicity) related to URM motivation and perceived success in research?

Following research questions and based on previous study findings, we hypothesized:

1. Faculty who are female, non-white, and of Latino ethnicity will be most likely to self-identify as URM (Carrigan *et al.*, 2011; Li & Koedel, 2017).
2. URM faculty members are likely to report experiencing a significant degree of discrimination within their academic workplaces (O'Meara *et al.*, 2020; Wilkins, 2017).
3. URM faculty would report lower levels of autonomous motivation for research than non-URM faculty (Stupnisky *et al.*, 2019; Deemer *et al.*, 2012)
4. URM faculty would report higher levels of discrimination and amotivation, while experiencing lower levels of autonomy, relatedness, and perceive of success in research, despite one known study on gender with evidence to the contrary (Barnett *et al.*, 1998).

By examining URM faculty with a large representative sample, established multi-item measures, and a well-grounded theoretical framework (see Figure 1), this study has the potential to fill critical gaps in research literature on faculty development, motivation, and research success, and to inform university administrators.

**Figure 1.** Conceptual Model of Faculty Motivation and Research Success Moderated by URM vs. non-URM.



## Method

### Participants and Procedure

In February of 2020, 821 STEM faculty members from 10 US Doctoral Universities (R2 Higher Research Activity Carnegie Classification) completed an online survey. We limited data analysis to faculty who had completed at least the majority of the survey and who reported some research requirements on their contracts, resulting in a final analyzed sample of 651 faculty.<sup>1</sup> Participant demographic and position details are in Table 1. More than half of the respondents were male (50.6%) and most of them were white (81.6%). Most of the faculty (92.5%) classified themselves as not of Hispanic, Latinx, or Spanish origin. Approximately one-quarter of faculty labeled themselves as international (27%). Most important to this study, 37.0% identified themselves as URM faculty.

More than one-third of the participants identified as an assistant professor (33.6%), however more than half (57.8%) of the respondents had a tenured position. The average career age (time from Ph.D.) was 13.65 years ( $SD = 10.1$ ), and participants worked an average of 51.4 hours per week ( $SD = 10.4$ ). Faculty reported the expected time on their contracts 40.4% ( $SD=20.5$ ) research, 36.4% ( $SD=19.4$ ) teaching, 12.9% ( $SD=10.5$ ) service, and 7.5% ( $SD=16.6$ ) other/administration.

**Table 1.** Full Sample Participant Characteristics.

|                                  |                                  | Count               | Percent |
|----------------------------------|----------------------------------|---------------------|---------|
| <b>Primary Disciplinary Area</b> | Life sciences                    | 178                 | 27.3    |
|                                  | Social sciences                  | 97                  | 14.9    |
|                                  | Engineering                      | 85                  | 13.1    |
|                                  | Psychology                       | 50                  | 7.7     |
|                                  | Geoscience                       | 46                  | 7.1     |
|                                  | Mathematical sciences            | 36                  | 5.5     |
|                                  | Chemistry                        | 33                  | 5.1     |
|                                  | Physics and astronomy            | 33                  | 5.1     |
|                                  | STEM education learning research | 30                  | 4.6     |
|                                  | CISE                             | 25                  | 3.8     |
|                                  | Materials research               | 5                   | 0.8     |
|                                  | No response                      | 33                  | 5.1     |
|                                  | <b>Academic Rank</b>             | Assistant Professor | 219     |
| Associate Professor              |                                  | 178                 | 27.3    |
| Full Professor                   |                                  | 212                 | 32.6    |
| Instructor/teaching professor    |                                  | 9                   | 1.4     |
| Research scientist/analyst       |                                  | 8                   | 1.2     |
| Other                            |                                  | 25                  | 3.8     |
| <b>Tenure Status</b>             | On tenure track but not tenured  | 209                 | 32.1    |
|                                  | Tenured                          | 376                 | 57.8    |
|                                  | Not on tenure track              | 63                  | 9.7     |
|                                  | Other                            | 3                   | 0.5     |

|  |   |     |      |
|--|---|-----|------|
| <b>Gender Identity</b>                             | Man   | 388 | 59.6 |
|  | Woman                                       | 255 | 39.2 |
|  | I prefer not to respond                     | 8   | 1.2  |
| <b>Racial Identification</b>                       | White                                       | 531 | 81.6 |
|  | Asian                                       | 82  | 12.6 |
|  | Multiracial                                 | 15  | 2.3  |
|  | Other                                       | 11  | 1.7  |
|  | Black or African American                   | 5   | 0.8  |
|  | No response                                 | 7   | 1.8  |
| <b>Ethnicity</b>                                   | Not of Hispanic, Latinx, or Spanish origin  | 602 | 92.5 |
|  | Yes, of Hispanic, Latinx, or Spanish origin | 42  | 6.5  |
|  | No response                                 | 7   | 1.1  |
| <b>International</b>                               | No  | 471 | 72.4 |
|  | Yes   | 176 | 27.0 |
|  | No response                                 | 4   | 0.6  |
| <b>Underrepresented minority (self-identified)</b> | No  | 407 | 62.5 |
|  | Yes   | 241 | 37.0 |
|  | No response                                 | 3   | 0.5  |

## Measures

### SDT Psychological Needs

A scale adapted from Stupnisky *et al.* (2017) measured faculty members' perceived level of need satisfaction regarding their research (see Table 2). Following the question, "Regarding your RESEARCH, to what extent do you agree with the following?" were twelve items equally distributed among three subscales (1=Strongly disagree, 5=Strongly agree): autonomy ("I have a sense of freedom to make my own choices."), competence ("I have confidence in my ability to do things well."), and relatedness ("I am supported by the people whom I care about [students, colleagues, etc.].").

**Table 2.** Full Sample Scale Reliabilities and Descriptive Statistics.

| Measure                    | $\alpha$ | # items | <i>M</i> | <i>SD</i> | Actual range | Skew  | Kurtosis |
|----------------------------|----------|---------|----------|-----------|--------------|-------|----------|
| <b>Basic Needs</b>         |          |         |          |           |              |       |          |
| Autonomy                   | .83      | 4       | 4.11     | 0.77      | 1-5          | -0.95 | 1.49     |
| Competence                 | .83      | 4       | 4.23     | 0.58      | 1.75-5       | -0.58 | 0.59     |
| Relatedness                | .86      | 4       | 3.93     | 0.71      | 1-5          | -0.65 | 0.69     |
| <b>Motivation</b>          |          |         |          |           |              |       |          |
| Intrinsic                  | .85      | 3       | 4.51     | 0.59      | 2-5          | -1.37 | 2.08     |
| Identified                 | .67      | 3       | 4.40     | 0.59      | 1.67-5       | -1.17 | 1.70     |
| Autonomous                 | .86      | 6       | 4.45     | 0.55      | 2-5          | -1.27 | 1.92     |
| Introjected                | .84      | 3       | 3.42     | 1.02      | 1-5          | -0.46 | -0.53    |
| External                   | .61      | 3       | 3.53     | 0.83      | 1-5          | -0.43 | -0.25    |
| Amotivation                | .82      | 3       | 1.86     | 0.84      | 1-5          | 1.14  | 1.21     |
| <b>Research Success</b>    |          |         |          |           |              |       |          |
| Activity                   | .81      | 3       | 3.35     | 0.76      | 1-5          | -0.38 | -0.09    |
| Publications               | .88      | 3       | 3.32     | 0.90      | 1-5          | -0.28 | -0.36    |
| Grants                     | .90      | 3       | 3.15     | 1.00      | 1-5          | -0.13 | -0.09    |
| Overall                    | .91      | 12      | 3.34     | 0.75      | 1.17-5       | -0.13 | -0.09    |
| Publications               | -        | 1       | 7.75     | 7.13      | 1-33         | 1.50  | 1.66     |
| Citations                  | -        | 1       | 27.20    | 39.71     | 0-225        | 2.45  | 6.55     |
| Field-normalized Citations | -        | 1       | 0.81     | 0.71      | 0-3.59       | 1.24  | 1.66     |

### Motivation

Motivation was measured using a scale adapted from Stupnisky *et al.* (2019). Regarding the question, “*To what extent are the following reasons for why you engage in RESEARCH?*” (1=Strongly disagree, 5=Strongly agree), faculty members responded to three items for each of five subscales (15 items total): intrinsic (“*It is enjoyable to engage in research.*”), identified (“*My research is important to me.*”), introjected (“*I would feel guilty not engaging in research.*”), external motivation (“*Because I am paid to produce research.*”), and amotivation (“*Honestly, I don’t know why I do research.*”). Exploratory factor analysis revealed the intrinsic and identified subscales should be combined to form the autonomous motivation subscale, which is consistent with past research on faculty motivation for teaching and research (Stupnisky *et al.*, 2018; 2019).

### Success

Faculty rated their perceived success in research over the last three academic years in three areas: conducting research activities, publishing research, and securing external grant funding for research. In each area they rated four items on a 5-point scale (1=Well below average, 3=Average, 5=Well above average): “*Your own standards*”, “*Your department’s standards for tenure and promotion*”, “*Colleagues in your department*”, and “*Colleagues in your field(s)*” (Stupnisky *et al.*, 2019).

Bibliometric indicators of faculty research success were also collected from the Web of Science that included publications, citations, and field-normalized citations (Waltman *et al.*, 2011a, 2011b) over the three years prior to the survey. Outliers were identified as those scores falling outside 97.5% of all scores and were trimmed; specifically, 12 faculty with more than 33 publications, and 12 faculty with more than 234 citations were removed.

### Discrimination

Six questions from Zambrana *et al.* (2017) were used to measure workplace discrimination. In response to the question, “*During your professional career, have you ever encountered the following?*”, participants were asked to rate three items for both gender and race/ethnicity on a four-point scale (1=Never, 2=Rarely, 3=Often, 4=Always). The items were, “*Gender [race/ethnicity] discrimination by superior or colleague*” and “*Left out of opportunities based on gender [race/ethnicity].*” They were then asked to “*Please rate how upsetting these experiences based on gender [race/ethnicity] were*” (1=Not at all upsetting..., 4=Extremely upsetting).

## Rational for Analysis

We used the R lavaan package (Rosseel, 2012) for all latent variable analyses. Criteria used to assess the model goodness of fit included: *chi*-square ( $\chi^2$ ), the comparative fit index (CFI > .95 indicates a well-fitting model, < .90 requires respecification; Bentler, 1990; Hu & Bentler, 1999), the root mean square error of approximation (RMSEA < .08 indicates an acceptable-fitting model, Browne & Cudeck, 1993; < .10 MacCallum, Browne, & Sugawara, 1996), and standardized root mean square error (SRMR < .05 indicates well-fitting model, Byrne, 2010; < .08, Hu & Bentler, 1999; < .10, Kline, 2005).

## Results

### Faculty Identification as URM

Data analyses were conducted in R (R Core Team, 2020). Of the 651 faculty analyzed in this study, 241 (37%) self-identified as URM (see Table 3). Those URM faculty identified primarily as women (81%) and to a lesser extent a non-white race (20%), or Hispanic, Latin, or Spanish ethnicity (14%). Cross-sections of the demographics revealed that the largest group of URM was white, non-Hispanic, women (150), followed by non-white, non-Hispanic, women (27). Expectedly, the largest group of non-URM faculty was white, non-Hispanic, males (279). Data showed that women made 15% of non-URM and non-white faculty made 16% of this group, which was surprising as these two groups are among the NFS’s defined URM categories for STEM fields (NCSES, 2020). Also, 25% of self-identified URM participants identified as “international” faculty member (born and raised outside of the US).

Considering job characteristics of self-identified URM, 37% were assistance professors, 25% associate professors, and 29% full professors, while the fewest were instructors, teaching professors, and research scientists at just over 9% (non-URM were 28.5% assistant, 31.7% associate, 34.9% full, 4.9% other). URM faculty were 52.7% tenured, 33.6% on tenure track, and 13.7% not on tenure track (non-URM were 60.4% tenured, 31.5% on tenure track, 7.4% not on tenure track). On average, URM faculty were lower ranked and

less tenured.

**Table 3.** Self-identified URM by Gender, Race, and Ethnicity.

| URM x Gender                      |           | URM (241)    |     | Non-URM (407) |     |     |
|-----------------------------------|-----------|--------------|-----|---------------|-----|-----|
| Men (388)                         |           | 44           | 19% | 344           | 85% |     |
| Women (255)                       |           | 194          | 81% | 60            | 15% |     |
| URM x Race                        |           |              |     |               |     |     |
| White (531)                       |           | 189          | 80% | 342           | 84% |     |
| Non-white (112)                   |           | 49           | 20% | 63            | 16% |     |
| URM x Ethnicity                   |           |              |     |               |     |     |
| Not Hispanic Latinx Spanish (602) |           | 204          | 86% | 398           | 98% |     |
| Yes, Hispanic Latinx Spanish (42) |           | 34           | 14% | 8             | 2%  |     |
| Gender x Race x Ethnicity         |           | URM          |     | Non-URM       |     |     |
| Men                               | White     | Not Hispanic | 12  | 4%            | 335 | 67% |
|                                   |           | Hispanic     | 18  | 6%            | 10  | 2%  |
|                                   | Non-white | Not Hispanic | 14  | 5%            | 65  | 13% |
|                                   |           | Hispanic     | 2   | 1%            | 1   | .1% |
| Women                             | White     | Not Hispanic | 185 | 64%           | 77  | 15% |
|                                   |           | Hispanic     | 11  | 4%            | 2   | .1% |
|                                   | Non-white | Not Hispanic | 38  | 13%           | 8   | 2%  |
|                                   |           | Hispanic     | 8   | 3%            | 0   | 0%  |

Note. Full sample counts for gender, race, and ethnicity in parentheses in first rows and column. Percentages may not sum to 100% due to rounding.

Breakdown of URM by disciplines revealed the vast majority of women in Engineering, CISE, Geoscience, Physics and Astronomy, Chemistry, and Mathematical Sciences identified as URM (56 URM, three non-URM). Alternatively, in Life Sciences (e.g., biology) women made up 43% of the faculty population, of whom 69% identified as URM. Of the remaining women who did not identify as URM, 22% were non-white. In the combined fields of Psychology and Sociology, women made up 59% of the faculty population. Despite being the majority, 72% of the women in these two fields identified as URM while less than 1% of the men self-identified as URM. Fifty-four percent of the faculty in STEM Education Learning Research were women compared to 43% men, however 80% of these women identified as URM compared to 2% of the men.

#### URM Faculty Discrimination

Among self-identified URM women, 86.6% reported experiencing some gender discrimination from a superior or colleague, and 80.7% felt that they have been left out of opportunities based on their gender (see Table 4). Only 8% of URM women who have experienced gender bias said that they were not upset at all, compared to 53.2% who said they were very or extremely upset.

**Table 4.** Responses to Discrimination items by URM faculty.

| Gender for URM females                  | Percent of Responses |      |      |      | M(SD)      | skew  | kurtosis |
|---|----------------------|------|------|------|------------|-------|----------|
|   | 1                    | 2    | 3    | 4    |            |       |          |
| Discrimination by superior or colleague | 13.4                 | 42.3 | 38.7 | 5.7  | 2.37(0.79) | -0.03 | -0.53    |
| Left out opportunities                  | 19.3                 | 44.3 | 31.3 | 5.2  | 2.22(0.82) | 0.15  | -0.60    |
| Discrimination was upsetting            | 8.0                  | 38.7 | 28.3 | 24.9 | 2.70(0.94) | 0.03  | -1.06    |
| <i>Race for URM non-whites</i>          |                      |      |      |      |            |       |          |
| Discrimination by superior or colleague | 22.5                 | 46.9 | 28.6 | 2.0  | 2.10(0.77) | 0.10  | -0.78    |
| Left out opportunities                  | 33.3                 | 47.9 | 18.8 | 0.0  | 1.85(0.71) | 0.21  | -1.08    |
| Discrimination was upsetting            | 23.8                 | 31.0 | 19.1 | 26.2 | 2.48(1.13) | 0.11  | -1.43    |

Note. Responses for gender discrimination shown only for self-identified URM women ( $n = 194$ ), and for race discrimination only for self-identified URM nonwhites ( $n = 49$ ). The top two bias questions were answered on the response scale: 1=Never, 2=Rarely, 3=Often, 4=Always. The third bias question was answered on the scale 1=Not at all upsetting, 4=Extremely upsetting.



For URM race, 77.6% of non-white URM faculty have been discriminated by superiors or colleagues based on their race or ethnicity, and 66.7% perceived that they have been left out of opportunities. Of those individuals, 45.2% of the URM posted high levels of discomfort (very or extremely upset) based on perceived discrimination.

#### URM Faculty Motivation for Research

The results of t-test revealed few significant differences (see Table 5). URM faculty, compared to non-URM, reported lower levels of autonomy ( $t = 2.40, p < .05$ ) and autonomous motivation ( $t = 2.11, p < .05$ ). Surprisingly, there were not many mean level differences between URM and non-URM faculty.

**Table 5.** Descriptive Statistics and t-tests for Self-identified URM vs. non-URM.

| Variable                   | URM | <i>n</i> | <i>M</i> ( <i>SD</i> ) | <i>t</i> | <i>Cohen's d</i> |
|----------------------------|-----|----------|------------------------|----------|------------------|
| <b>Basic Needs</b>         |     |          |                        |          |                  |
| Autonomy                   | No  | 399      | 4.16(0.60)             | 2.40*    | .20              |
|                            | Yes | 235      | 4.03(0.74)             |          |                  |
| Competence                 | No  | 402      | 4.25(0.54)             | 1.63     | .14              |
|                            | Yes | 233      | 4.17(0.64)             |          |                  |
| Relatedness                | No  | 401      | 3.92(0.70)             | -0.33    | .03              |
|                            | Yes | 233      | 3.94(0.73)             |          |                  |
| <b>Motivation</b>          |     |          |                        |          |                  |
| Autonomous                 | No  | 394      | 4.49(0.51)             | 2.11*    | .18              |
|                            | Yes | 234      | 4.39(0.59)             |          |                  |
| External                   | No  | 396      | 3.54(0.80)             | 0.38     | .03              |
|                            | Yes | 238      | 3.51(0.88)             |          |                  |
| Introjected                | No  | 399      | 3.38(1.01)             | -1.54    | .13              |
|                            | Yes | 240      | 3.51(1.03)             |          |                  |
| Amotivation                | No  | 396      | 1.82(0.81)             | -1.39    | .12              |
|                            | Yes | 238      | 1.92(0.89)             |          |                  |
| <b>Success</b>             |     |          |                        |          |                  |
| Overall, Self-report       | No  | 399      | 3.35(0.73)             | 0.50     | .04              |
|                            | Yes | 233      | 3.32(0.77)             |          |                  |
| WOS Publications           | No  | 262      | 7.31 (6.62)            | -1.02    | .11              |
|                            | Yes | 147      | 8.08 (7.73)            |          |                  |
| WOS Citations              | No  | 261      | 25.54 (37.60)          | -0.06    | .00              |
|                            | Yes | 148      | 25.76 (38.25)          |          |                  |
| WOS Field Normed Citations | No  | 249      | 0.79 (0.75)            | -0.30    | .03              |
|                            | Yes | 133      | 0.77 (0.65)            |          |                  |

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

WOS = Web of Science bibliometric data

Correlations revealed that for URM women, experiences of gender discrimination were negatively linked to autonomy ( $r = -.18, p < .01$ ) and relatedness to others ( $r = -.31, p < .001$ ), and positively related to amotivation ( $r = .18, p < .01$ ; see Table 6). There were no correlations between the gender discrimination items and success. Alternatively, among URM non-white and Hispanic/Latinx/Spanish faculty, experiences of race/ethnicity bias correlated with greater perceived success, perhaps indicating those who are performing well are more likely to experience discrimination from others.

#### Discrimination Related to URM Motivation and Research Success

Analyses began by fitting a measurement model with all study latent variables. Results supported convergent validity based on strong factor loadings of items on latent variables and an acceptable goodness of fit (see Table 7). Next, we analyzed the hypothesized structural model, which posited that faculty basic psychological needs for research were positively associated with autonomous motivation and in turn positively related to self-reported success; alternatively, extrinsic and amotivation would have small or negative

**Table 6.** Correlations for URM faculty between Motivation, Bias, and Success.

|                     | Gender Discrimination     |                           |           | Race/ethnicity Discrimination |                           |           |
|---------------------|---------------------------|---------------------------|-----------|-------------------------------|---------------------------|-----------|
|                     | By superior or colleagues | Left out of opportunities | Upsetting | By superior or colleagues     | Left out of opportunities | Upsetting |
| Autonomy            | -.18**                    | -.18**                    | -.15*     | .01                           | .03                       | -.02      |
| Competence          | .04                       | .01                       | .03       | .12                           | .14                       | .00       |
| Relatedness         | -.31***                   | -.29***                   | -.21**    | .02                           | -.05                      | .09       |
| Autonomous          | -.01                      | -.09                      | .01       | .17                           | .09                       | .25       |
| Introjected         | -.04                      | -.02                      | .04       | .05                           | -.02                      | .17       |
| External            | .02                       | .01                       | .03       | -.15                          | -.09                      | -.12      |
| Amotivation         | .18**                     | .22***                    | .09       | -.19                          | -.10                      | -.19      |
| Self-report Success | .07                       | -.02                      | -.02      | .27*                          | .23*                      | .10       |
| Publications        | .00                       | .05                       | -.01      | -.18                          | -.19                      | -.16      |
| Citations           | .14                       | .09                       | .04       | .00                           | -.09                      | .04       |
| FN Citations        | .12                       | .07                       | -.08      | .16                           | .12                       | .04       |

Note. Correlations for gender bias were analyzed only for self-identified URM women (194), and correlations for race/ethnicity bias were analyzed only for self-identified URM who were non-white or Hispanic/Latinx/Spanish ethnicity (83). FN = Field Normalized Citations  
 \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

relationships with basic needs and success. Finally, faculty self-reported URM vs. non-URM was included as a moderator in a multi-group analysis.

**Table 7.** Model Goodness of Fit.

| Model                         | df   | $\chi^2$ | RMSEA | CFI  | SRMR | $\Delta$ CFI | $\Delta \chi^2$ (df) | $p$   |
|-------------------------------|------|----------|-------|------|------|--------------|----------------------|-------|
| Measurement model             | 657  | 1510.23  | .047  | .939 | .056 |              |                      |       |
| Configural (baseline) model   | 1318 | 2367.82  | .052  | .926 | .074 |              |                      |       |
| Metric invariance             | 1349 | 2402.31  | .052  | .926 | .076 | .000         | 34.49 (31)           | .30   |
| Structural invariance         | 1374 | 2463.71  | .052  | .923 | .082 | .003         | 95.89 (56)           | <.001 |
| Partial structural invariance | 1363 | 2423.12  | .052  | .926 | .087 | .000         | 55.30 (45)           | .14   |

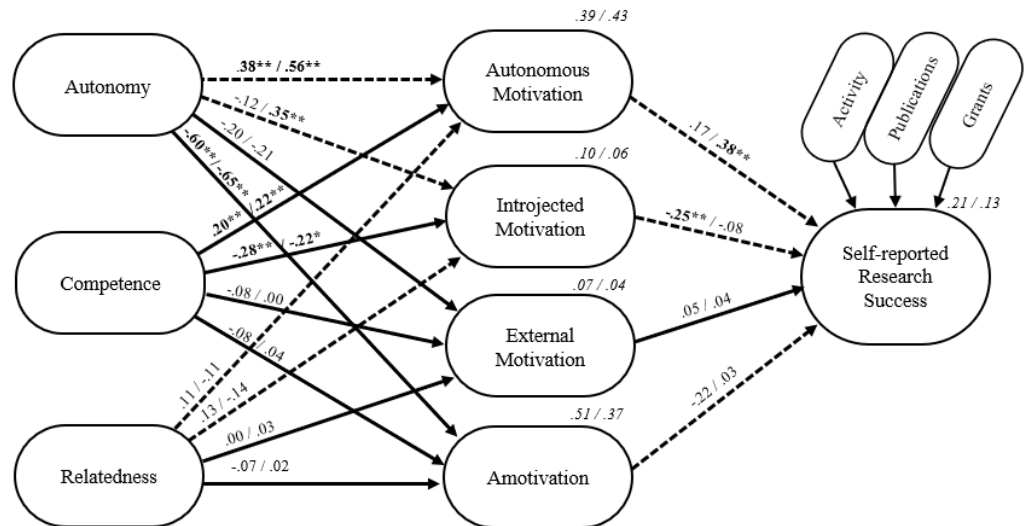
Note. The full model tested the hypothesized structure with no groups, the configural model had the URM groups specified with no constraints, the metric invariance model contained the factor loadings to be equal across the groups, the structural invariance model constrained the regression paths and latent covariances across the groups, while the partial structural invariance model freed the regression paths and latent covariances with the largest differences between the groups until the model was no longer significant different from the metric invariance model.

The configural structural model, which analyzed the regression paths for both groups (no constraints), had adequate goodness-of-fit to the data (see Figure 2). This indicates the two groups conceptualized the underlying latent constructs similarly. Metric (weak) invariance was tested by constraining all latent variable factor loadings and reanalyzed, with the result showing no difference from the configural model. This result suggests roughly equivalent strength of relations between items and latent constructs for URM versus non-URM faculty. Next, structural invariance was tested by constraining all regression paths and latent covariances, which yielded a significant difference between the groups compared to the configural model. Paths with the largest differences between the groups were systematically freed until the model became nonsignificant in a partial structural invariance model, and those paths were deemed different between the groups.

For both groups, autonomy ( $\beta = .38$  for URM &  $\beta = .56$  for non-URM,  $p < .01$ ) and competence ( $\beta = .20$  for URM &  $\beta = .22$  for non-URM,  $p < .01$ ) had significant positive predictive relationships with autonomous motivation, accounting for 39–43% of the variance. In turn, autonomous motivation was positively related to research success, however only significantly so for non-URM faculty ( $\beta = .38$ ,  $p < .01$ ). Interestingly, URM faculty had a significantly weaker connection of autonomous motivation to self-reported research success. For both groups, competence was significantly negatively related to introjected motivation ( $\beta = -.28$  for URM &  $\beta = -.22$  for non-URM,  $p < .05$ ); furthermore, autonomy positively predicted introject motivation among non-URM while for URM this was slightly negative. Introjected motivation was a significant negative predictor of research success for URM ( $\beta = -.25$ ,  $p <$

.01), but not for non-URM. For both groups, autonomy had large significant negative paths to amotivation ( $\beta = -.60$  for URM &  $\beta = -.65$  for non-URM,  $p < .05$ ). The remaining paths in the model were not statistically significant, although there were some significant differences between the groups in their strength. For instance, the connection of relatedness with autonomous and introjected motivation was positive for URM faculty, but negative for non-URM faculty. Also, amotivation was negatively related to research success for URM faculty, but nearly zero for non-URM.

**Figure 2.** Configural Structural Model of Faculty Motivation and Research Success.



Note. URM coefficients appear left of slash, and non-URM coefficients on right. Bold coefficients with stars are significant at \*  $p < .05$ , \*\*  $p < .01$ . Dashed lines are significantly different across groups.

## Discussion

The current study examined how faculty who identified as an underrepresented minority (URM) in STEM reported discrimination, and how that experience related to their motivation and success in conducting research. We first examined which of the STEM faculty in our sample self-identified as URM. They were primarily white women, and not of Hispanic/Latinx/Spanish ethnicity, which is consistent with past studies (Carrigan *et al.*, 2011; Li & Koedel, 2017). Interestingly, 15% of those not identifying as URM were women and 16% were non-white faculty, despite being among the NFS's defined URM categories for STEM fields (NCSES, 2020). This may be due to working in STEM disciplines that have more diversity (e.g., social sciences), or purposefully disassociating themselves with minority status for reasons that require further research. It was also found that URM faculty were lower ranked and less tenured than non-URM faculty, which is a unique finding but in line with other studies finding lower research productivity for URM faculty (Antonio, 2002; Lauer, 2021).

As expected, URM faculty disclose substantial levels of workplace discrimination based on gender and race/ethnicity (O'Meara *et al.*, 2020; Wilkins, 2017); however, this study was the first to examine how these experiences correlated with URM faculty motivation to conduct research. URM women reported substantial levels of gender-based discrimination in their workplace that correlated with less autonomy and relatedness with colleagues, as well as increased amotivation. The findings may provide some rationale for why women, relative to men, have been found to have fewer publications, citations, and grants (Larivière *et al.*, 2013; Beaudry & Larivière, 2016) and report an inadequate work environment (Hill *et al.*, 2010; Kaminski & Geisler, 2012; Stupnisky *et al.*, 2015). Faculty who identified as non-white or of Hispanic, Latinx, or Spanish ethnicity also reported workplace discrimination, although to a lesser degree than URM women. Interestingly, the research success of non-white and Hispanic/Latinx/Spanish faculty was correlated with increased discrimination, perhaps indicating that successful URM faculty were resented for their success. This finding aligns with some studies referring to URM faculty's lower number of journal articles, books publications, and research productivity, despite their high commitment to research activities (Antonio, 2002). As well as why pre-tenure female faculty and faculty of color reported less

satisfying collegial relationships (Ponjuan *et al.*, 2011).

Mean level comparisons showed URM faculty reported less autonomy and lower autonomous motivation than non-URM faculty. This supports decades of research indicating URM faculty have unique motivational experiences (Schoen & Winocur, 1988; Wiley *et al.*, 1979), and specifically supports prior studies finding differences on SDT variables of autonomy and autonomous motivation (Stupnisky *et al.*, 2019). We found no significant differences on research success measures, either self-reported or bibliometric from Web of Science, which is not consistent with past research (Beaudry & Larivière, 2016; Larivière *et al.*, 2013).

The most unique contribution came from the SEM analyses that found the associations between motivation and research success was unique for URM faculty. As expected autonomous motivation was strongly related to research success for non-URM faculty (Stupnisky *et al.*, 2017), however for URM faculty this effect was much smaller. Alternatively, URM research success was more strongly predicted by low levels of introjected and amotivation. The more predominant role of maladaptive motivations is troubling as they could negatively manifest as non-action and lower productivity. This finding aligned with Lechuga's perception that URM faculty negatively internalize the emotional stress related to institutional cultures that could affect their motivation to do research (2012a; 2021b). URM faculty were also unique because relatedness had a positive relation to autonomous motivation. This supported the findings by Kumar and Ratnavelu (2016), as well as Lechuga (2012a), that URM faculty value networking and collaborations more than non-URM researchers.

## Limitations and Future Directions

This study contributes to the research literature on faculty development, research success, and motivation by examining URM faculty with a large representative sample, established multi-item measures, and a well-grounded theoretical framework. A limitation of this study was that other URM groups were not measured, such as those related to socioeconomic status, disability, and sexuality, which should be considered for future studies. Furthermore, the data for the current study was cross-sectional and thus the predictive validity is limited. Implications for faculty development include support for diversity training among university faculty and administrators as discrimination based on gender and race/ethnicity was found here to have an impact on faculty motivation.

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**Dr. Robert Stupnisky** arrived at UND in 2010 after completing his PhD at the University of Manitoba and a postdoctoral fellowship at Laval University. He is interested in how motivation and emotions affect individual's success higher education, initially studying college students and more recently focusing on university professors as director of the Faculty Motivation Research Group. Dr. Stupnisky teaches educational psychology, research methods,

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## Footnotes

<sup>1</sup>The breakout of the missing data indicated that out of original participants 56 (6.8%) had next to no data entries and most of their variables missing; 38 (4.6%) were missing the majority of data entries in the motivation and perceived success sections; 5 (0.6%) had a substantial number of variables missing; and 71 participants (8.6%) had zero research percentage.

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