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The Role of Social Support on the Relationship between Gender and Career Progression in STEM Academia

Andrew S. Folz

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THESIS

Andrew S. Folz, Captain, USAF

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Andrew S. Folz, BS

Captain, USAF

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Andrew S. Folz, BS

Captain, USAF

Approved:

__//SIGNED//_____	18 Dec 2014
John J. Elshaw, PhD (Chair)	Date
__//SIGNED//_____	18 Dec 2014
Vhance V. Valencia, PhD, Maj, USAF (Member)	Date
__//SIGNED//_____	18 Dec 2014
Christina F. Rusnock, PhD, Maj, USAF (Member)	Date

Abstract

This research serves as an introduction to examining the role of gender as an influence on social connections and career progression in the academic science, technology, engineering, and math (STEM) environment. This research will examine whether gender impacts the social connections with coworkers, which in turn may impact career progression and advancement in STEM. Using statistical analysis methods, this study looks to answer whether women in the STEM teaching profession have the same social connections in their workplace as men and whether these connections are related to organizational advancement. Results from the analysis support the impact of network connections on the relationship between publication rate and academic advancement. Publication rate is clearly related to academic advancement, however this relationship is stronger for women with fewer network connections. For women with a higher number of network connections, publication rate was not as strong of a predictor of academic advancement.

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THE ROLE OF SOCIAL SUPPORT ON THE RELATIONSHIP BETWEEN GENDER AND CAREER PROGRESSION IN STEM ACADEMIA

I. Introduction

This chapter serves as an introduction to research examining the role of social support as an influence on the relationship between gender and career progression in the science, technology, engineering, and math (STEM) academic environment. The research will hopefully determine whether social support impacts the career progression for men and women in academe. The thesis topic will be explained in detail to include information about the thesis background, the problem statement, the methodology, and thesis limitations.

Background

Minorities such as women are underrepresented in the areas of STEM, including university faculty. This missing representation has been established through several recent studies including a study by the National Science Foundation. Despite making up over half the population of the United States, only 28% of the STEM workforce in the U.S. is female. The percentage of full professorships at educational institutions filled by women is 22% in science, engineering, and health doctorates (National Science Foundation, National Center for Science and Engineering Statistics, 2013). These statistics suggest that universities are not hiring or retaining women at the same rate as men. It is entirely possible that the imbalance contributes to new female students

avoiding STEM academic careers. Understanding the factors that contribute to this disparity should assist universities and other programs in developing a countermovement to achieve gender equality.

Problem Statement

Although several factors have been indicated to contribute to gender imbalance in STEM this thesis will look primarily at the impact of social support or social connections and how it affects the career progression of women and men at the workplace. A disadvantage facing women in STEM faculty positions is a lack of support or a perception of not fitting in at the workplace as STEM faculties have high ratios of male professors. Lack of social support can lead to withdrawal and other destructive behaviors (Terence, Brooks, Thomas, Chris, & Erez, 2001). Social support has been found to buffer stress and supply advancement to those participating in the community. Because so few women are in faculty positions in academic science and engineering departments, they are missing the support component afforded the male majority. One theory is the reason so few women are in STEM professions is lack of advancement and support due to fewer social connections and less support. The lack of social support in the workplace disadvantages women while their male coworkers use the male majority to generate support and opportunities for advancement.

Methodology

The primary methodology used in this study was statistical analysis. The statistical analysis included linear regression and model building to find correlations

among factors. Academic rank was regressed against hypothesized predictors using multiple regression analysis to determine which predictors raise the explained variance or r-squared value. The research also used statistical analysis to determine if any factors could be considered a mediator of other study factors. The sample for this study was comprised of professors in STEM departments at universities in the Midwest. Information about each faculty member was recorded from public information sources to determine gender, measures of success, published works, and social networking factors.

Assumptions and Limitations

This thesis ran into several limitations and the research was affected by certain assumptions for the validity of this study. One limitation of this study was the limited access to data for analysis. Final collection of the sample data hinged on information sources that had to be public and available. The public information sources used to gather data to include university directories, LinkedIn profiles, and Google Scholar were assumed to be accurate and current unless evidence existed to the contrary. Another assumption was that sample members had public online social networking accounts with LinkedIn and that use of the network was not biased by gender or other factors. If none of the sample members had accessible accounts from which to record information, the analysis would be restricted. An additional limitation of this study was that all conclusions made could only be considered accurate for the selected sample and would not necessarily reflect the STEM community in many cases. Because the data gathering was limited to a smaller selection of universities in the Midwest, it was possible that the

sample would not be representative of universities in other regions or even any other universities in the United States.

Summary

This study looked to answer whether women in the STEM teaching profession have the same social support in their workplace as men and if this was a hindrance to success in the sample set. A positive relationship between social support and success would support the adage "It's not what you know, it's who you know" and provide insight to challenges to women in less diverse professions. Understanding the reasons diversity is lower in the STEM academic profession is necessary to counteracting the imbalance. The research accomplished here should be used in advocacy programs and schools to assist in providing missing support to those women currently in STEM and brightening the future of those considering this profession.

II. Literature Review

Introduction

Women are currently underrepresented as faculty in colleges and universities in the United States and are found in even fewer numbers in the science and engineering departments. According to a Science and Engineering Indicators report, "In 2010, women constituted only 28% of workers in these occupations, even though they accounted for nearly half of the college-educated workforce" (National Science Board, 2014). As women have been increasingly accepted both as students and faculty in academe over the years, the physical sciences and engineering tenure tracks have remained dominated by males. The difference in hiring is noticeable at universities where less than a quarter of the faculty is female in the fields of physical sciences and engineering (Ceci, Williams, & Barnett, 2009).

Researchers have attempted to determine the reasons that women represent so few numbers in academia especially in science, technology, engineering and mathematics (STEM). Attempting to reveal the cause of gender disparity in university faculty, researchers suggested several theories. A few of these theories concerned gender discrimination, unintentional policies by universities, family and marriage obligations, biological differences, and natural ability. Several studies are discussed to show the background of gender studies and the direction of this thesis effort.

Past Research on Women on University Faculties

In 1986, Sandler and Hall published research showing gender discrimination was a frequent practice in university policies. The authors described these harmful practices as part of the reason for high turnover in the female faculty. Inputs from female faculty members at universities across the United States provided examples of the discriminatory practices in the report. Men in the career field were frequently belittling the merits of the female faculty and focused only on the physical attributes of their female colleagues. The women responding to the study had been treated as outsiders and excluded from possible networking opportunities. Sandler and Hall concluded that women were at a disadvantage fighting the discrimination due to their smaller numbers and called for male faculty to eliminate discriminatory practices and attitudes towards their female colleagues (Sandler & Hall, 1986).

In the 1990s, Olsen, Maple, and Stage studied women and minorities in faculty positions to understand how they were treated and their sense of job satisfaction. The authors suggested that demand for female faculty increased but women were primarily employed at less prestigious schools focused more on associate and bachelor education than high level research. Women were not as well represented as men at research universities or in the sciences. According to the article, gender stereotyping was still an issue for women in STEM while treatment in other fields improved. The authors suggested that unconscious stereotyping of women at research universities led to females leaving resulting in fewer of them in engineering and science. Olsen et al. determined that women were given less support at most universities and suffered in job satisfaction because of this handicap. Women were also disconnected in office politics and left out of

extracurricular activities resulting in missed opportunities in these networking functions (Olsen, Maple, & Stage, 1995).

In a 1996 study, Jacobs reported that women were underrepresented in prestigious schools particularly those with an engineering program (Jacobs, 1996). Jacobs concurred with Olsen et al. that women were underrepresented as faculty with the effect more pronounced among full professors. He cited a report from 1994 that showed 47.9% of lecturers were female and only 17.2% of full professors were female (National Center for Education Statistics, 1994). The reason for the disparity according to Jacobs was the number of disadvantages women had to overcome in the path from higher education to professorship. He cited research from Rothstein (1995) that women who had female advisors continued their course of study in higher numbers (Jacobs, 1996). Those women who found a network of support at schools with a higher proportion of female faculty would be more likely to excel in education (Tidball, Women's Colleges and Women Achievers Revisited, 1980; Tidball, Baccalaureate Origins of Recent Natural Science Doctorates, 1986).

Several years later in 2008, Wolfinger, Mason, and Goulden published their research on the role of the family on women in academe. The data showed that while females had become more prevalent as faculty in the 2000s, they still remained locked out of the highest ranks. Only 26% of full professors were female as of a 2001 report from the American Association of University Professors (American Association of University Professors, 2001). Wolfinger et al. hypothesize that women have had to adapt to the "male career model" in the academic workplace and there was no room for families which forced many women to leave the career field or devote less time to career

advancement (Wolfinger, Mason, & Goulden, 2008). Their research found that women with young children were less likely to find tenure track positions. The authors were unable to account for why women were not as well represented as men in tenured academic positions (Wolfinger, Mason, & Goulden, 2008).

A 2009 study by Ceci, Williams, and Barnett also examined research on women in academia and the reasons for the lingering lack of representation especially at the highest ranks in STEM. The authors similarly found that women emphasized family more than men and felt a pressure to leave the career field to devote time to family. Despite determining that women frequently had less time to pursue careers when raising young children, Ceci et al. stated that this phenomenon was not unique to women in STEM career fields and should affect members of all fields equally. The study also could not ascertain the full reason behind women not being represented in tenured positions (Ceci, Williams, & Barnett, 2009).

Role of Social Support

One disadvantage mentioned several times in the research is that women lack support from their departments and universities. Due to lack of numbers, women have not had the social connections that come naturally to men in the male-dominated fields of science, mathematics, and engineering. Faculty members that are less connected frequently feel less commitment to their job or workplace. (Feeley & Barnett, 1997) The effect of women having less commitment in the office network could be higher turnover for women in that department or university. The higher likelihood of turnover for employees with fewer connections and less commitment has been supported by past

research and was labeled the Erosion Model. (Feeley & Barnett, 1997) Women with a larger network in their field would have more role models, mentors, and supporters for assistance and a higher feeling of connectedness and commitment. The social encouragement would have a positive effect on retention and promotion of women in the field and make it more likely for women with supporting connections to progress through the tenure track.

Networking and mutual support in the workplace has been shown to help workers in several ways. Leader-Chivee and Cowan reported that connectedness such as through online communities and networks could improve individual engagement and performance at work (Leader-Chivee & Cowan, 2008). Research suggested another benefit of networking was improved coworker morale and organizational innovation through increased collaboration (Bennett, Owers, Pitt, & Tucker, 2010). Having a support group providing these benefits is an important resource, especially for women who already have a smaller cohort in STEM faculties. Additional research suggested that women benefit more from a support network for stress mitigation than men. According to Taylor, Klein, Lewis, Gruenewald, Gurung, and Updegraff, women have been more likely than men to seek out support especially from other women (Taylor, et al., 2000). Despite the body of research on the disadvantages facing women in STEM academe, little research has been attempted to determine if social support is a factor in women achieving tenure and promotion in the male dominated fields.

The previous research left questions to how social support affected academic faculty. These questions were looked at by the analysis of this thesis and developed into

three hypotheses. This thesis explored the role of social support on gender in academic faculty members by establishing the accuracy of the following three hypotheses:

Hypothesis One: Social support moderates the relationship between gender and academic rank in STEM faculties resulting in individuals with more support being less affected by the relationship between gender and academic rank. To establish the validity of the hypothesis, gender must first be shown to predict academic rank in the sample case for this study.

Hypothesis Two: Gender moderates the relationship between quantity of published articles and academic rank. The relationship affects women more than men so that women have a larger volume of published works than men at the same rank.

Hypothesis Three: Social support *mediates* the relationship between gender and academic rank as women have fewer cohorts on academic faculties resulting in less social support which negatively affects representation at higher academic ranks.

The methodology of this thesis effort will explain how social support will be measured and tested in the sample. The methodology will also establish how each hypothesis will be validated and how the final results will be produced.

Summary

The review of literature on the subject reveals that women have frequently faced disadvantages in reaching tenure in science and engineering fields. Whether facing outright discrimination or difficulty overcoming the demands of a field shaped by the male majority, female faculty have had difficulty attaining the same status as males in STEM. One of the disadvantages mentioned but rarely studied is the lack of social

support for women in these fields. Social support has been suggested as an important performance enhancer and stress reducer for women in particular and was studied in more detail through this research effort. The next chapter explains how the research was conducted in the thesis.

III. Research Methodology

Introduction

The purpose of this chapter is to describe the methodology used in this thesis and explain its use. This section explains the research process and the tools that are used for analysis. The sample set is described and data gathering techniques are discussed for clarity and repeatability. The analysis determines if the hypotheses in Chapter II are supported.

Sample

The sample population for this study was comprised of professors in STEM academic departments at two universities in the Midwest region of the United States. The universities were selected due to ease of access of public information and proximity. A private university and a state college were both included in the study. The sample consists of tenure track faculty members who have finished a PhD program. The members were selected from each engineering department listed by the university's online directory. All members for which information could be found were added to the data set for the research.

Data Gathering

Data gathered in this study was obtained from several sources. The majority of the data were collected directly from public information sources such as university department directories and all names or identifying information was removed to maintain

anonymity. Collecting information from the directories included recording individuals' names, university, position, gender, department, year completed PhD, and curriculum vita if available. The data were found on the online university directory and written down in a database for later analysis. Additional data were retrieved from the online social network (OSN) site LinkedIn to gather the number of network connections and number of endorsements. The data was collected by searching for a specific faculty member using the LinkedIn member search to find a matching public profile. The profile was compared to the individual's current position to ensure accuracy then the stated number of connections and number of endorsements on the member's profile were recorded in the database. These two variables represented social support in the testing process. The data were used to determine if OSNs are a valid data source and if social support can be determined from OSN member information. To collect the number of published articles, both collaborative and solo, Google Scholar was used. Google Scholar is an online search engine that allowed the search of study members through an author search. Each result produced by the author search was looked at to ensure the author of the article was the member in question, to see whether or not the work was co-authored, and to verify that the result was a peer-reviewed journal article or refereed conference paper. Collected study data from all sources included gender, OSN factors (number of connections and number of endorsements), professional position or rank, and number of published works with differentiation between solo works and those published with peers. Professional performance will be measured by academic status in rank. There are three ranks in the tenure track used for this study: assistant professor, associate professor, and professor. The tenure track for faculty starts at assistant professor. The next level of

status is associate professor which is where tenure starts for a faculty member. The highest rank for a faculty member is professor. Social support was quantified by three variables in this study. The ratio of coauthored papers to total number of papers (labeled proportion of articles coauthored), number of LinkedIn connections, and number of LinkedIn endorsements were the three variables used in analysis. To be considered coauthored, the peer-reviewed article had to have the member in question's name in the author section alongside another author's name. The total number of papers published was used to determine level of effort to reach academic rank.

Approach

After all data were collected for this study, moderation and mediation analysis was used to explore interactions among the factors. All analysis in this thesis was accomplished using the statistical software SPSS. Dependent variables from the sample were regressed against hypothesized predictors using multiple regression analysis or "t-tests" to determine which predictors were significant and raised the explained variance or r-squared (R^2) value. Gender was coded as a categorical variable to use in both the regression analysis and any models developed to highlight differences in the statistical means between men and women on the dependent variable. In this coding, the male characteristic was given a value of one and the female characteristic was given the value zero. The ratio of solo published works to total published works was developed as a predictive variable indicating the relative amount of network collaboration in the workplace which for this study was considered social support. Number of LinkedIn connections and endorsements was used as a social support variable to show the effect of

OSN-based social support on other factors in the models. The predictor variables have also been placed in the model individually and in selected groupings to determine the best fit based on largest coefficient of determination.

Other approaches used in the research include study of moderation and mediation. In using basic correlation testing, a t-test can show whether the independent variable correlates or predicts the dependent variable. Moderation is when a third variable affects the relationship between the independent variable and dependent variable. This third variable, or moderator, can magnify or minimize the effect of the original relationship. Moderation is "an interaction whereby the effect of one variable depends on the level of another" (Frazier, Tix, & Barron, 2004). An example of moderation would be how precipitation affects the relationship between external temperatures and a desire to go swimming to cool off. While higher temperatures can make swimming as an activity more desirable, the presence of rain might explain a time when the relationship is not as strong and high temperatures no longer invoke a desire to go swimming. Mediation shows how a relationship between independent variable and dependent variable exists. "A mediator is the mechanism through which a predictor influences an outcome variable" according to Baron and Kenny (1986; Frazier, Tix, & Barron, 2004). An example of mediation is season, temperature, and ice cream sales. While season or time of year may predict ice cream sales effectively, the season generally correlates to average temperatures which then correlate to ice cream sales. In the example, the temperature is the mediator between season and ice cream sales. The three hypotheses tested in this thesis include either moderation or mediation. More about the specifics of the testing methods is found in the next section.

Research Objectives

The objective of this research is to find support for the hypotheses stated in Chapter II and listed below.

- Hypothesis One: Social support moderates the relationship between gender and academic rank in STEM faculties resulting in individuals with more support being less affected by the relationship between gender and academic rank.

- Hypothesis Two: Gender moderates the relationship between quantity of published articles and academic rank.

- Hypothesis Three: Social support mediates the relationship between gender and academic rank as women have fewer cohorts on academic faculties resulting in less social support which negatively affects representation at higher academic ranks.

The rest of this chapter explains the details and methods behind testing each hypothesis and the objectives behind each one.

Method for Testing Hypothesis One

To test the first hypothesis, support for each relationship in the hypothesis must be found. The relationships in the hypothesis are modeled in Figure 1. The first relationship to establish is gender must predict rank. To support the relationship, a t-test with the

gender dummy variable as the independent variable and academic rank as the dependent variable was performed. Assuming this test was successful in supporting the initial relationship, the next relationship determined was that social support correlates to the dependent variable, academic rank. This relationship has to be found to show support for moderation. The reason this support is important to the moderation relationship is if no correlation is found between the moderating variable and the dependent variable, it proves that the moderator does not affect the dependent variable and therefore does not affect the original relationship. (Frazier, Tix, & Barron, 2004) This relationship was also tested through a t-test in SPSS. The final test for support of the moderation relationship was testing the interaction between independent variable and moderator. The interaction was represented by the product of the independent variable and the moderator. The interaction, independent variable, and moderator were all put in a multiple regression test to determine correlation with the dependent variable. The important effect to consider in the multiple regression test or F-test was the significance of the interaction variable and ignoring the independent variable and the moderator as they can become insignificant when added to the multiple regression test. (Frazier, Tix, & Barron, 2004) The significance of the interaction variable determines if there is support for a moderation relationship and supports the hypothesis.

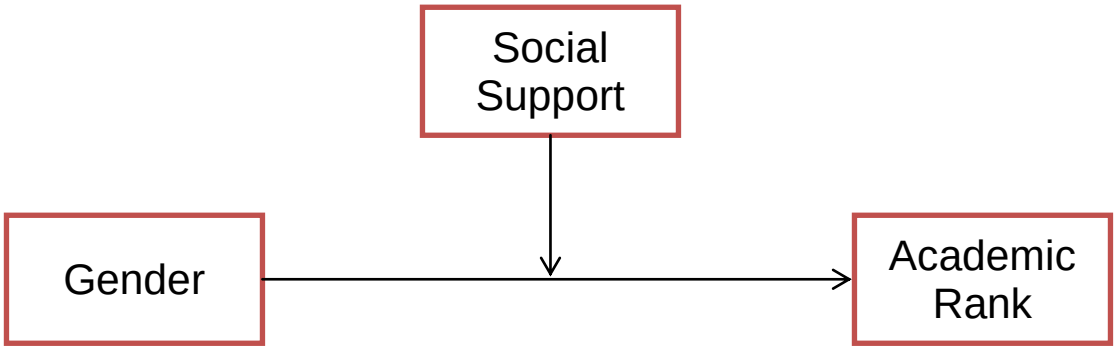

Figure 1: Social Support as a Moderator of the Relationship between Gender and Academic Rank

Method for Testing Hypothesis Two

The second hypothesis examined the possible moderation effects of gender on the relationship between number of articles and academic rank. A model showing the hypothesis can be found in Figure 2. The methods to show moderation in the first hypothesis were replicated in the testing of the second hypothesis with a simple change in variables. The independent variable became the number of articles which could be considered a measure of level of work or effort on the part of a faculty member. The dependent variable was still academic rank. The moderation variable for this hypothesis was changed to the gender dummy variable. The same t-tests and multiple regression tests used to test support for Hypothesis One were used to test support for Hypothesis Two as well.

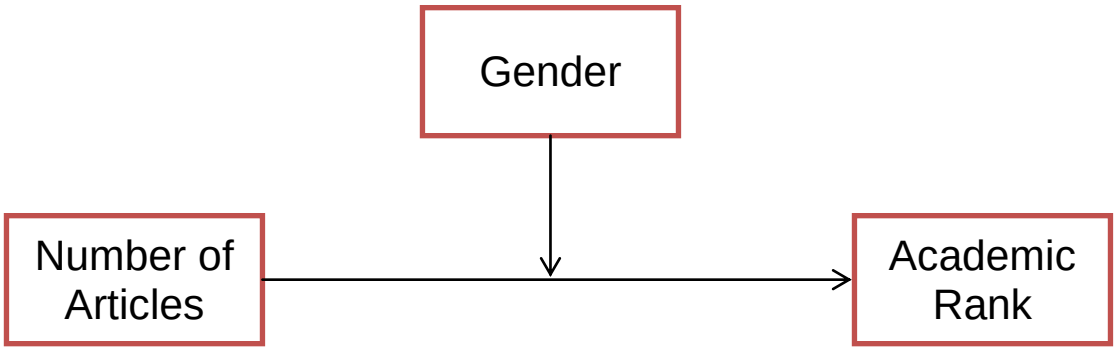

Figure 2: Gender as a Moderator of the Relationship between Number of Articles and Academic Rank

Methods for Testing Hypothesis Three

The third hypothesis tested was the mediation relationship modeled in Figure 3. The independent variable was the gender dummy variable, the dependent variable was still academic rank, and the mediator was social support. The first step to test support for mediation was to ensure the independent variable predicts the dependent variable. The second step in the method was to determine that the independent variable predicted the mediator. Establishing the relationship was important as no mediation can exist if the mediating variable is not predicted by the independent variable. (Frazier, Tix, & Barron, 2004) The third step in testing the hypothesis was to test the relationship between the mediator and the dependent variable. The three tests were performed using t-tests in SPSS. The final step was to determine if the mediator variable was acting as a complete or partial mediator between the independent variable and dependent variable. The last step was tested by using a stepwise regression first with only the independent variable on the dependent variable and then with the mediating variable added. If the correlation between the independent variable and the dependent variable was no longer significant, it

would be considered complete mediation. If the correlation stays significant after dropping from the added variable, the mediation is partial.

Figure 3: Social Support as a Mediator of the Relationship between Gender and Academic Rank

Summary

The methodology describes how the research in this paper was accomplished. The sample set and data gathering techniques were also included in the methodology and explained in this section. The concepts of moderation and mediation were explained to show how they related to each hypothesis. The methods to test each of the three hypotheses were covered to show when the analysis supports or undermines each. The next chapter shows the results of the analysis and what was discovered in the data set for this thesis.

IV. Results

Sample

The sample data include 65 faculty members, 15 of which are female and 50 are male. Of the 65 members in the sample, 7 had characteristics that could not be verified and had to be removed from consideration. All those removed were male. This left 58 members in the sample. The number of years of experience of the faculty members ranged from 1 year to 50 years with the average being 18.7 years of experience. There are 17 assistant professors, 16 associate professors, and 31 professors in the sample. Table 1 shows the other descriptive statistics for the sample.

Table 1: Descriptive Statistics for Sample

	Minimum	Maximum	Sum	Mean	Std. Deviation
Gender DV (1=Male)	.00	1.00	50.00	.7692	.42460
Google Scholar Articles	0	192	2658	42.87	38.863
Years of Experience	1.00	50.00	1141.00	18.7049	11.08955

Results of Hypothesis Testing

Hypothesis One: Social Support as a Moderator

To test the first hypothesis, support for each relationship in the hypothesis must be found. The first relationship to be tested is the correlation between gender and academic rank. The relationship is tested using linear regression the results of which are in Table 2.

Table 2: Relationship between Gender and Rank

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	5.972	1	5.972	9.501	.003
Residual	38.966	62	.628		
Total	44.938	63			

Predictors: (Constant), Gender DV (1=Male)
Dependent Variable: Rank

Results of analysis supported the hypothesis that gender is a predictor of the rank of faculty in the sample collected. Since the relationship between gender and rank has been shown to be statistically significant (where $\alpha = 0.05$), the testing of further hypotheses based on this relationship was relevant.

The second test determined if social support moderated the relationship between gender and rank. To establish the relationship, support for the moderator correlating to the dependant variable, academic rank, must be found. The first variable used to represent social support was the proportion of published works coauthored with others. The proportion was determined by dividing the number of published works with a coauthor by the total number of published works. How often an individual received help in publishing a paper could have shown the frequency of support from a network. The relationship was tested using linear regression and the results can be found in Table 3.

Table 3: Relationship between Proportion of Articles Coauthored and Rank

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1.351	1	1.351	1.920	.171
Residual	40.832	58	.704		
Total	42.183	59			

Predictors: (Constant), Proportion of Articles Coauthored
Dependent Variable: Rank

When testing if social support predicts rank, the analysis showed that there is little correlation between amount of social support as measured by proportion of coauthored articles and rank. Because there was no established relationship, making an argument for proportion of articles coauthored being a moderator was difficult. Another path was to use a different variable for social support so number of LinkedIn connections would be tested and number of LinkedIn endorsements would be tested.

Table 4: Relationship between Number of LinkedIn Connections and Rank

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1.097	1	1.097	1.551	.218
Residual	43.841	62	.707		
Total	44.938	63			

Predictors: (Constant), Number of Connections
Dependent Variable: Rank

Table 4 shows the results of the regression between number of connections and rank. The significance level was higher than 0.05 showing that number of connections did not explain the variance in this relationship. At this point control variables were looked at to determine if the number of connections variable could explain variance once

a significant portion of unexplained variance was removed from the model. The most explanatory variable found through testing was years of experience. The relationship between rank and years of experience was highly significant as shown in Table 5. Another descriptive statistic, the R^2 value or explained variance shows that 50% of the total variance in measured rank was explained by years of experience. The data for the R^2 value using years of experience to predict rank are in Table 6.

Table 5: Relationship between Years of Experience and Rank

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	21.226	1	21.226	58.326	.000
Residual	21.107	58	.364		
Total	42.333	59			
Predictors: (Constant), Years of Experience Dependent Variable: Rank					

Table 6: R^2 Values for Relationship between Years of Experience and Rank

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	.708[a]	.501	.493	.60326
Predictors: (Constant), Years of Experience				

The idea that most of the variance in this sample was explained by years of experience made logical sense. The longer one is in a career field, the more experience and skill can be gained resulting in an ability to achieve higher rank. If the variable, years of experience, was added to a model as a control variable to explain much of the variance, smaller effects from other variables could be made more significant. The new

regression test in Table 7 shows the relationship between number of connections and rank to hold significance since more variance is already explained by the control variable.

Table 7: Relationship between Number of Connections and Rank with Years of Experience as a Control Variable

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.143	.155		7.376	.000
Years of Experience	.054	.007	.708	7.637	.000
(Constant)	.899	.169		5.325	.000
Years of Experience	.057	.007	.746	8.439	.000
Number of Connections	.001	.000	.254	2.880	.006
Dependent Variable: Rank					

The same control variable could be added to the regression test of the relationship between number of endorsements and rank. The results of the relationship are shown in Table 8. The number of endorsements variable was not significant at the 0.05 significance level and therefore was not a strong predictor of rank.

Table 8: Relationship between Number of Endorsements and Rank with Years of Experience as a Control Variable

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.143	.155		7.376	.000
Years of Experience	.054	.007	.708	7.637	.000
(Constant)	1.082	.159		6.816	.000
Years of Experience	.054	.007	.707	7.706	.000
Number of endorsements	.001	.001	.138	1.502	.139
Dependent Variable: Rank					

Since number of connections was the only social support variable that was significant in predicting rank it then was the only variable tested for moderation of the relationship between gender and rank. To test social support as a moderator the interaction between the gender dummy variable and number of connections variable was regressed along with the gender and number of connections variables. The variable, years of experience, was also used as a control variable. The regression in

Table 9 shows that the number of connections was not a strong moderator of the relationship between gender and rank as it was not significant.

Table 9: Relationship between Gender and Rank as Moderated by Number of Connections

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.143	.155		7.376	.000
Years of Experience	.054	.007	.708	7.637	.000
(Constant)	.680	.219		3.112	.003
Years of Experience	.053	.007	.688	7.242	.000
Gender DV (1=Male)	.402	.251	.207	1.599	.115
Number of Connections	.002	.001	.423	2.136	.037
Gender * # Connections	-.001	.001	-.217	-.989	.327
Dependent Variable: Rank					

Since no social support variables were shown to moderate the relationship between gender and rank, the first hypothesis looked at in this thesis was not supported and must be rejected.

Hypothesis Two: Gender as a Moderator

The next hypothesis to test was that the number of publications predicted rank and that gender was a moderator of the relationship. To test the two relationships, linear regression was used. The first test looked to show correlation between number of publications and academic rank. The result of this test is shown in Table 10. The test showed that the number of publications written by a faculty member was a significant predictor of the member's rank.

Table 10: Relationship between Number of Publications and Rank

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.785	.144		12.432	.000
Google Scholar Articles	.010	.002	.476	4.159	.000
Dependent Variable: Rank					

After showing that the number of publications predicted rank, the next step in testing moderation was determining if gender could be used as a moderating variable. Support for the gender dummy variable predicting rank was determined previously in the section on the first hypothesis. The support was verified in Table 2 for gender predicting rank. Because both number of publications and gender were shown to predict rank in the sample, a test of moderation was accomplished through a linear regression. The results of this test are shown in

Table 11. A control variable, years of experience, was used to control for unexplained variance.

Table 11: Relationship between Number of Articles and Rank with Gender as a Moderator

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.166	.164		7.127	.000
Years of Experience	.053	.007	.693	7.126	.000
(Constant)	.679	.209		3.246	.002
Years of Experience	.043	.008	.561	5.562	.000
Google Scholar Articles	.014	.004	.631	3.403	.001
Gender DV (1=Male)	.626	.237	.328	2.639	.011
GenderDVinteractionNumArticles	-.011	.005	-.498	-2.330	.024
Dependent Variable: Rank					

The results in

Table 11 show that the interaction between gender and number of articles was a significant predictor of rank. The test supported the idea that gender was a moderator of the relationship between number of articles published and rank. The second hypothesis was strengthened by the results of the analysis and could not be rejected.

Hypothesis Three: Social Support as a Mediator

The third hypothesis to be tested was that social support mediates the relationship between gender and rank. To test for mediation, the independent variable would have to predict the mediating variable and the dependent variable and the mediating variable would have to predict the dependent variable. The mediation relationship was then qualified by adding both the independent variable and the mediator in stepwise regression in SPSS. The relationship between gender and rank was already established with the first hypothesis. In the hypothesis three test, gender would have to predict social support to lend support to the hypothesis. The result of the test is shown in

Table 12.

Table 12: Relationship between Gender and Proportion of Articles Coauthored

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.938	.047		19.978	.000
Gender DV (1=Male)	-.091	.054	-.214	-1.682	.098
Dependent Variable: Proportion of Articles Coauthored					

The results showed that while gender did not consistently predict proportion of articles coauthored, it likely would have been predictive at a lower significance level (ie: α=0.10 instead of the more conservative α=0.05). Since the relationship was not completely predictive using proportion of articles coauthored, another variable was analyzed as the possible mediating social support variable. Number of LinkedIn connections was used for the second test as the social support variable. The regression test of the relationship between gender and number of connections is shown in

Table 13.

Table 13: Relationship between Gender and Number of Connections

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	140.200	42.755		3.279	.002
Gender DV (1=Male)	5.720	48.748	.015	.117	.907
Dependent Variable: Number of Connections					

The results of the analysis in

Table 13 showed that gender was not a predictor of the social support variable, number of connections. The third variable used to represent social support was number of endorsements. The regression test of the relationship between gender and number of endorsements is shown in Table 14.

Table 14: Relationship between Gender and Number of Endorsements

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	43.400	26.155		1.659	.102
Gender DV (1=Male)	12.780	29.822	.054	.429	.670
Dependent Variable: Number of endorsements					

Since the significance was much greater than 0.05 no relationship between gender and number of endorsements was supported by the sample data. The use of a control variable in the regression analysis did not make the relationships significant in any of the three representative variables for social support. Since no relationship could be found between gender and a mediating social support variable the hypothesis was not supported.

Summary

The results of the study showed whether each hypothesis was supported. The testing results for the first and third hypotheses did not support the whole hypotheses however correlation was found between gender and rank in academia. Building on the correlation, the second hypothesis showed that gender has a moderating relationship

between the quantity of published works and rank. The meaning behind the results and other items of discussion are looked at in detail in the next chapter.

V. Discussion

Introduction

In this chapter, the results from the previous chapter were discussed to provide meaning to the analysis and show the benefits and shortcomings. The discussed topics include limitations to the study, review of the results, and recommendations for future research.

Review of the Results

To determine whether the thesis hypotheses were supported, each was tested in and results shown in the previous chapter. Support was found for one of the hypotheses but not the other two. To understand why two hypotheses failed and what the positive result means all hypothesis tests and results are discussed.

In testing each hypothesis, two were not supported by the sample gathered in this study. Confirmation was not found for social support being a moderator or a mediator of the relationship between gender and academic rank. In testing the first hypothesis, gender was found to correlate with rank. This shows that a higher proportion of men have attained the tenured ranks than women in the sample collected. Supporting the correlation is important because it is a key test of all three hypotheses in this thesis. In the first hypothesis testing the role of social support as a moderator, only one social support variable (number of connections) was found to correlate with academic rank. When tested for moderation effects, the results found no confirmation that number of connections moderated gender's correlation with rank. One of the reason as to why the

relationship was not supported is a small sample size. The small sample makes it difficult to detect smaller effects. A larger sample size would provide a better chance to find smaller size effects in the sample reflecting a characteristic of the even larger population. One interesting takeaway shown by the results of the hypothesis testing is that number of connections correlates to the academic rank. While correlation does not mean causation, the correlation might be explained by the idea that knowing more people and having a larger network can help an individual advance in rank. The mediation relationship was not supported by the results of the third hypothesis test. Again this failure is likely due to the small sample size which limits the power of the analysis.

The second hypothesis tested looked at gender moderating the relationship between number of articles and academic rank. The hypothesis was supported by the test used in the methodology suggesting that gender moderates the number of published works by faculty members at higher ranks. In this case, the number of published articles increases with rank but the increase is much steeper for females than males. One explanation of the supported relationship is that women must produce a larger volume of published works than men to attain similar rank in academia. Because only correlation is tested and supported in the results of this study, other causes should be considered before drawing a final conclusion from the data.

Limitations

Almost all studies come with limitations of the research and what can be gained from analysis of the sample involved. In this study the limitations included a small

sample size, restricted sources of data, and the possibility of unrepresentative variables for social support.

The collected sample initially included data from 65 individuals. Because all data had to come from public sources the sample was incomplete and not all required information could be found on each individual in the study. For instance, for three individuals the number of published scholarly articles could not be verified and for four individuals the years of experience could not be established. The lack of information meant that the data are incomplete and those individuals could not be used to evaluate the validity of the hypotheses in the study. Only 58 individuals in the data collection were used for the hypothesis testing because of lack of verified information on the rest.

Another limitation that arose from the public sources is the difficulty to find and record the data needed for the sample. The process to search for and then verify information sources was extremely time-consuming and did not allow for a large sample size. The smaller sample does not allow for discovery of effects with medium or small power. The moderating or mediating effect of social support on the gender-rank relationship may not be a large power effect which would make finding significance of the effect difficult due to a smaller sample size.

The data collection process did not capture the complete author information of each article published by the sampled faculty members. Because of the lack of information, no additional analysis could be accomplished on coauthors to determine validity to be used in this study. It could have been possible that faculty members are co-publishing with students which could undermine the social support variable, proportion of articles coauthored. Another area for concern would arise from faculty members who

had always published with the same group. The group may offer more or less support to the faculty member than an individual who frequently published articles with many different coauthors. Future research could look into these issues and determine how they affect this thesis and future studies.

An issue with the initial assumptions could be another limitation to the study. Since social support has not been widely studied in a manner similar to this thesis, the assumptions about social support variables being representative could be mistaken. No literature could be found supporting the validity of LinkedIn connections or endorsements as a type of social support. If this assumption is wrong then using these two variables to represent social support on an individual would be a mistake.

Recommendation for Future Research

The areas of future research related to this thesis effort include further research on social support in academe especially STEM, the use of online social networks (OSNs) as sources of data, and additional research to determine validity of using certain variables to represent social support in studies.

Studying the effects of social support in specific career fields is an important area for future knowledge development. Since little is known about the role of social support in STEM career fields especially in academic setting, additional work could determine whether the results of this thesis are unique or common. Researchers should study how social networks affect women and men separately to see if there is a difference. Finding how each gender responds to support in this matter would allow universities and other organizations to cater specifically to gender differences to create an even playing field.

Additional research in other areas of the country would also be beneficial to determine if external validity holds true in this study. The data from this thesis effort came from universities in the Midwest which may not be representative of other regions of the United States. Social support could affect members of certain regions differently that the members of the Midwest as well. Increasing the sample size and number of represented regions should create a more representative sample of the entire US. Looking at how social support changes when using unique faculty members or always using the same group to co-publish research could be a new avenue to explore in STEM research as well.

Another area of research that should be pursued is the use of online social networks as data sources for studies. LinkedIn is a recent addition to the number of OSNs that include Facebook and Twitter. The vast number of users on each OSN makes all of these sites a potential fountain of information. The recovery of information on OSNs could also be a tricky legal issue with consumers uncomfortable with their information being used without knowledge or control in certain circumstances. As OSNs grow in popularity and importance, the possibilities may outweigh the downsides which more research into the feasibility of OSNs as data sources could determine.

The use of OSNs in this thesis also brings the question of whether the variables used in the study properly reflect social support or would other measurements be more effective. One of the key assumptions in the study was that number of LinkedIn connections and endorsements could be used to measure a level of social support. On the surface this would seem true but little research was found to support the assumption. Future research could look at the formation of OSNs and determine if the number of connections on LinkedIn or number of friends on Facebook reflects an individual's level

of social support. The understanding of the meaning behind connections on an OSN could also help in determining how valuable these connections are as reflections of support and if using the variables in similar studies is unfounded or not.

Summary

This thesis investigates the problem of why women are not represented at higher academic ranks in STEM fields. Using linear regression and moderation/mediation analysis, lack of social support was looked at as a possible cause for the lack of representation. Ultimately the goal of this thesis is to study the issue of gender imbalance that has been found in academia and determine the possible roots of the inequity.. The results of the effort should lend some help in directing further research in minority studies in STEM and help current educational institutions in finding ways to support all faculty members no matter their gender.

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Vita

Captain Andrew S. Folz graduated from Needham B. Broughton High School in Raleigh, North Carolina. He entered undergraduate studies at North Carolina State University in Raleigh, North Carolina where he graduated with a Bachelor of Science degree in Civil Engineering in May of 2009. He was commissioned through Detachment 595 AFROTC also at North Carolina State University.

His first assignment was at Nellis AFB, Nevada with the 99th Civil Engineer Squadron starting in August of 2009 where he served as the Deputy Section Chief in the Engineering Flight. While stationed at Nellis AFB, he was deployed in support of Operation IRAQI FREEDOM and Operation NEW HOPE to Joint Base Balad in Iraq for six months as a construction project manager. After his return, he was made the Chief of Project Management for the 99th Civil Engineer Squadron, Operating Location Alpha at Creech AFB, Nevada. His next assignment was at Osan Air Base, Republic of Korea where he was made the Asset Optimization Section Chief for the 51st Civil Engineer Squadron in June of 2012. After graduation, Capt Folz will separate from the United States Air Force and assume a position with the State of North Carolina as a Project Engineer for the NC Department of Transportation.

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14. ABSTRACT

This research serves as an introduction to examining the role of gender as an influence on social connections and career progression in the academic science, technology, engineering, and math (STEM) environment. This research will examine whether gender impacts the social connections with coworkers, which in turn may impact career progression and advancement in STEM. Using statistical analysis methods, this study looks to answer whether women in the STEM teaching profession have the same social connections in their workplace as men and whether these connections are related to organizational advancement. Results from the analysis support the impact of network connections on the relationship between publication rate and academic advancement. Publication rate is clearly related to academic advancement, however this relationship is stronger for women with fewer network connections. For women with a higher number of network connections, publication rate was not as strong of a predictor of academic advancement.

15. SUBJECT TERMS
Gender, STEM, Social Support, Moderation, Mediation