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Effects of Changes in Student Major Choice on Faculty Salary and Department Hiring

Faculty Sponsor

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Abstract

Since the Great Recession, student major choices have shifted from majors such as English and humanities to science, technology, engineering, and mathematics (STEM) areas, especially computer science and health areas. This research seeks to examine the effects of changes in student major choice on faculty salary and hiring practices in corresponding departments. Using data from the University of Memphis, analysis is performed in two parts. The first part examines 32 majors to determine the relationship between student enrollment and average faculty salary. The second part examines the relationship between changes in student enrollment and changes in total teaching faculty in corresponding departments. This research finds virtually no correlation between enrollment and faculty salary, and very slight negative correlation between enrollment and number of teaching faculty.

Introduction

Since the Great Recession, there has been a significant shift in postsecondary student decisions regarding academic major. Student major choices have shifted from fields such as English and the humanities to science, technology, engineering, and mathematics (STEM) areas, especially computer science and health areas. Many of these students were motivated by their memories (or the memories of their parents) of the recession to gain an education that will lead to a steady and stable flow of income after graduation and believe that choosing a major in a STEM area will lead to a greater chance of securing such employment. This shift towards STEM majors has been well-documented and raises the question of how universities are responding after such a dramatic change. More specifically, how do universities make choices about the allocation of labor and wage levels in response to these changes in demand? As students move towards STEM, do universities hire more professors in STEM areas, or just increase the student-to-faculty ratio? How do they alter the salaries of faculty in fields with changing levels of student demand? This research sets to explore these questions and develop explanations, using data and evidence from the University of Memphis.

Literature Review

This research has two main branches: the effect of student major choice on faculty salary, and the effect of student major choice on department hiring. This section will first examine how students make major choices, and therefore the driving force of these changes in demand.

Changes in Student Demand

Since the 2008-2009 academic year, student major choices have shifted from English and humanities to science, technology, engineering, and mathematics (STEM) areas, especially computer science and health areas. According to data compiled by the National Center for Education Statistics (Department of Education, 2020b), English language and literature majors have declined by 27.2% from the 2008-2009 academic year to the 2017-2018 academic year, the largest drop for any major area tracked by the center. Given that college enrollment has increased 26.7% in that same time, this decline is quite dramatic. In that same timeframe, enrollment in STEM programs increased dramatically: health professions and related programs saw the largest increase at 119.5%, followed by computer and information science at 106.6%, engineering at 78.3%, and mathematics and statistics at 66.5%. This data is summarized in Table 1. Given this data, it is clear that students are moving towards STEM majors at high rates.

Blom, Cadena, and Keys (2015) examined how major choices change when people are exposed to different economics conditions. The authors examined field-of-study questions available in the 2009 American Community Survey, which produced a roughly 1% cross-sectional sample of the United States in which holders of bachelor's degrees reported their field of study and age. The authors combined data from the five annual surveys from 2009-2013 and were able to calculate the distribution of college majors for cohorts turning age 20 from 1960-2011. This initial analysis served to determine whether major choices change over the business cycle. The authors then supplemented cyclicality estimates with characteristics of majors from the 1993 Baccalaureate and Beyond survey (Department of Education, 2020a). They then combined these two data sources by creating a standardized list of 38 major categories to use in the analysis. The authors found that birth cohorts exposed to higher unemployment rates during typical schooling years selected majors that earn higher wages, have better employment prospects, and more often lead to work in a related field. Furthermore, the authors found that recessions encourage women to enter male-dominated fields, and students of both genders pursue more difficult majors, such as STEM fields. The authors suggest that these findings show that the economic environment changes how students select majors.

Russel Weinstein (2017) examined how local labor markets at the time of a student's college career can drive their major decisions. He examined four shocks (the dot-com crash, the fracking boom, the 2008 financial crisis, and the shock making Delaware a financial headquarters) and analyzed how students in a majorly affected area reacted regarding their major of choice. He used university-level data tracking bachelor's degrees attained by discipline; for major economic events, he used IPEDS to obtain total degrees awarded. Weinstein determined that economic shocks and their corresponding local labor markets did influence students when choosing a major, but these effects varied in timing, longevity, and intensity.

This data and prior research suggest that students are influenced by economic conditions when making decisions regarding academic majors, and move towards STEM majors during and following periods of economic downturn. Blom, Cadena, and Keys (2015) showed that birth cohorts exposed to higher unemployment rates during schooling years tend to choose more difficult majors, such as those in STEM areas. Weinstein (2017) found that local labor market conditions influence students when choosing a major, but this influence is not consistent. This research shows the cause of the shift towards STEM majors since the 2008-2009 academic year.

Changes in Department Size

Johnson and Turner (2009) examined how faculty resources are allocated in higher education. Using data from the National Research Council (NRC), the Integrated Postsecondary Education Data System (IPEDS), and the Higher Education General Information Survey (HEGIS-IPEDS), the authors examined the ratio of undergraduates to faculty at 132 institutions. Johnson and Turner concluded that core social sciences such as economics and political science exhibited higher student demand per faculty ratio as opposed to sciences and humanities. They make the claim that this is due to political forces within institutions that prefer certain disciplines rather than an appropriate allocation of resources.

Becker, Greene, and Siedfried (2011) specifically examined faculty size in relation to undergraduate and Ph.D. students. They used a regression analysis of the economics departments of 42 institutions over 14 years. They primarily used data from the American Economic Association (AEA). The number of undergraduates was obtained from the AEA's Universal Academic Questionnaire. Ph.D. data was obtained from the governmentally sponsored Survey of Earned Doctorates. Their data ranges from 1990-2006 (except for the 1998-1999 academic year).1 They conclude that bachelor granting institutions get a new faculty member for every increase of 10 undergraduate students and Ph.D. granting institutions obtaining a new faculty member at a one-to-one basis. However, this is less likely to occur in both bachelor granting and Ph.D. granting institutions when only presented with long term data and no short-term, current demand. Thus, furthering the idea that faculty size and student demand is based on political drive of the institution.

Bound and Turner (2006) examined how student demand and crowding in institutions affects graduation rates. They primarily used census data and IPEDS, as well as the HEGIS-IPEDS. They estimate that a state-wide increase of 10% in college population causes a 4% decline in degree completion. This mainly affects public institutions due to their inability to increase the resources needed for a higher demand of students. While it is not major-specific, this result is significant because it highlights the fact that some institutions may not be able to keep up with the demand of students through hiring new faculty.

Much of the prior research suggests that the allocation of faculty in higher education institutions is not to pursue efficiency but is more often influenced by internal political forces as well as internal and external financial restrictions. It is also worth noting that there is a general increase in the hiring of adjunct faculty as student demands increase, because universities can increase class offerings at a lower cost than if they were to hire more tenure-track professors, which can substantially benefit students.

Changes in Faculty Salaries

Johnson and Turner (2009) also looked at salary and student demand in their research. For salary data in specific fields, they used the Faculty Salary Survey by Oklahoma State University (which only covers National Associate State Universities and Land-Grant Colleges.) They noted that there wasn't complete overlap between the NRC data they obtained and the OSU data but assumed that the relative relationship of salaries between the two data sources would vary a negligible amount. They found that higher paid departments have a higher student-to-faculty ratio. They found it important to note that faculty salary expenditures per student were lower in the higher paid disciplines.

Goolsbee and Syverson (2019) directly measured monopsony power in different higher education institutions, also primarily using IPEDS data. They found that higher quality (measured using the Carnegie standard) institutions and larger institutions had more monopsonic power, with no difference regarding geographic region or gender of the prospective faculty. They also found that institutions generally had much more monopsonic power over tenure track faculty when compared to their non-tenure track counterparts because of issues regarding mobility. The authors could not conclude how the faculty member's salary was affected by the monopsonic power. It could be that if the market were perfectly competitive, schools would have to give raises or risk losing faculty. However, given that faculty have mobility issues and there are often few universities in a local area, these universities do not have to give faculty raises in response to changes in student demand.

This research shows that departments with a high student-faculty ratio have higher salaries, and the opposite is true for departments with low student-faculty ratios. It is also true that universities have power over their tenure and tenure-track faculty because mobility is an issue for these professors. While this power could be modeled to show that this would prevent faculty from getting raises, this has not been proven. Other factors also affect professor salaries, a main influence being seniority within the department.

Summary of Prior Research

Student demand is driven by many factors, but the most relevant seems to be the state of the economy at the time. The allocation of faculty in higher education institutions is not to pursue efficiency but is more often influenced by internal political forces as well as internal and external financial restrictions. Departments with a high student-faculty ratio have higher salaries,

and the opposite is true for departments with low student- faculty ratios.

Insights from Economic Theory

Consider a labor market for computer science and English professors. Initially, the markets are identical, with both types of professors requiring the same training, a Ph.D., and are engaging in the same work activities, teaching and research. Initially, demand and supply of both are equal, so both markets bring about the same wage W_0, and the quantity of professors hired by the university are represented by Q_{0C} and Q_{0E}.

As has occurred in the years since the recession, suppose that the demand for computer science professors increases, and the demand for English professors decreases. Initially, this causes an excess demand for computer science professors of $Q_{1C} - Q_{0C}$, and an excess supply of English professors of $Q_{0E} - Q_{1E}$. In this situation, there are three ways that the university can respond to these changes in demands: 1) let the market work, 2) keep all wages constant, and 3) raise all wages. The following models assume that universities can freely raise and lower faculty salaries and freely hire and fire professors.

Letting the market work means to increase wages when demand increases and decrease wages when demand decreases. In this situation, demand for computer science increases and shifts from D_{0C} to D_{1C}. This causes the university to increase the wage from W_0 to W_{1C}, and the quantity of computer science professors to increase from Q_{0C} to Q_{2C}. Demand for English professors decreases and shifts the demand curve from D_{0E} to D_{1E}. This causes the university to decrease the wage from W_0 to W_{1E}, and the quantity of English professors to decrease from Q_{0E} to Q_{2E}.

A second possibility is choosing to keep wages constant in the face of changing demands. If this were to occur, then in this situation demand for computer science increases and shifts from D_{0C} to D_{1C}, but because wages are kept at W_0, the quantity demanded is Q_{1C} and the quantity supplied is Q_{0C}. This leads to an excess demand of computer science professors of $Q_{1C} - Q_{0C}$. Demand for English professors decreases and shifts the demand curve from D_{0E} to D_{1E}. The wage again stays constant at W_0 so that the quantity demanded is Q_{1E}. and the quantity supplied is Q_{0E}, leading to an excess supply of English professors of $Q_{0E} - Q_{1E}$.

Thirdly, universities could respond to these excesses by lowering hiring standards for computer science professors and raising hiring standard for English professors, and the quality of these professors would reflect this change. Additionally, faculty size and course offerings would not change to accommodate these changes in student demand. A university may also

choose to raise the wages of all professors when demand increases for one type of professor. In this situation, demand for computer science increases and shifts from D_{0C} to D_{1C}, and once again causes the equilibrium wage to increase from W_0 to W_{1C}, and the quantity of computer science professors to increase from Q_{0C} to Q_{2C}. Demand for English decreases and shifts the demand curve from D_{0E} to D_{1E}, but now the wage increases from W_0 to W_{1C}, so that the quantity demanded is Q_{3E} and the quantity supplied is Q_{4E}, which exacerbates the surplus of English professors shown in the previous situation, raising it to $Q_{4E} - Q_{3E}$. Universities would respond by hiring fewer English professors and reducing course offerings, while also raising the hiring standards for English professors, again increasing average quality.

When student demand changes, the preceding situations are the ways that a university may respond in the form of faculty salaries and hiring. These situations assume that universities can freely raise and lower faculty salaries and freely hire and fire professors. According to economics theory, it is likely that in response to an increase in student demand in an area, faculty hiring will increase. Salaries of faculty in this area will also likely increase. In areas where student demand decreases, it is likely that departments will shrink, and there will be decreases in salary.

Method

Three datasets were used while conducting this research. The first two datasets were requested and obtained from the University of Memphis Office of Institutional Research. The third dataset was obtained online, in part from the University of Memphis website (Office of Institutional Research, 2019), and in part from an article published by the Memphis Business Journal ("University of Memphis 2014 salaries database").

The first dataset included the number of students with declared majors in various fields of study, with values for each fall semester from 2007 to 2019. This dataset was edited before analysis. Firstly, the values for the year 2007 were omitted with the goal of better aligning with the dataset of faculty salaries, which ranged only from 2008 to 2019. Concentrations within majors were counted as a single major. For example, an English major with a concentration in linguistics and an English major with a concentration in literature would both simply be counted as an English majors. Additionally, several specific majors were removed from this dataset. These included Academic Focuses, which are categories (Business, Humanities, STEM, Social Sciences, etc.) that first-year students are grouped into before declaring a specific major. Undecided students and students listed as having no major were also omitted. Majors that did not have a positive number of students

enrolled for each fall semester from 2008 to 2019 were also omitted, with two exceptions: Foreign/World Languages and Literatures and Management/ Business Information.

The Department of Foreign Languages and Literatures experienced a name change to the Department of World Languages and Literatures (which also changed the name of the major). Therefore, the number of students listed as having majors with either of those names in any given fall semester were combined into one value. Similarly, the Management Information Systems department and major were renamed as Business Information Technology, so those values were also combined. There were two sets of majors that shared a department which were combined into one value to, again, better align with the dataset of faculty salaries. The Economics (B.A.) and Business Economics (B.B.A.) majors were combined, because they are both under the Economics department, and the Computer Engineering and Electrical Engineering majors were combined for the same reason. Majors that did not have a clear corresponding department were omitted, including majors such as Professional Studies, Individual Studies, and Interdisciplinary Studies. After these edits and omissions, there were 32 majors that were usable for analysis. This dataset can be found in the appendix in Table 2, with ΔE indicating the percent change in student enrollment in the corresponding major from 2008 to 2019.

The second dataset included the average salary for faculty members in corresponding departments with the titles of Professor, Associate Professor, Assistant Professor, and Instructor with unique values for each position and each year from 2008 to 2019. An abbreviated version of this dataset, edited to show one combined average salary for all four positions for each department, can be found as Figure 2 in the appendix, with ΔS indicating the percent change in average salary from 2008 to 2019.

The third dataset included the name, title, department, and salary of every faculty member at the University of Memphis. For the year 2014, this data was obtained from the website of the Memphis Business Journal ("University of Memphis 2014 salaries", 2014*)*. The Memphis Business Journal continued to publish similar data for the years following 2014, but future publications contained data that was inconsistent and incomplete for some departments. Because of this, the same data for the year 2019 was obtained online from the University of Memphis website (Office of Institutional Research, 2019), which did not contain the same data for the year 2014. Using this data, values for total faculty in each department were derived. These totals included the following positions: Chair, Professor, Assistant Professor, Associate Professor, Holder of the Chair of Excellence, Instructor, Lecturer,

Senior Lecturer, and visiting faculty holding the preceding positions. Note that staff positions such as Administrative Assistants and positions with no teaching obligations were not included. This dataset can be found as Table 2 in the appendix, with ΔC indicating the percent change in total faculty from 2014 to 2019 and ΔE* indicating the percent change in student enrollment in the major of the corresponding department from 2014 to 2019, which was derived from the first dataset.

The analysis portion of this research will be conducted in two parts. The first part will examine the relationship between student major choice and faculty salary in corresponding departments. This will use the student major enrollment dataset and the average faculty salary dataset, along with the corresponding percentage change values for student major enrollment and average faculty salary, ΔE and ΔC, respectively. This will include data from the years 2008 to 2019 and will produce a linear regression as well as the correlation coefficient and coefficient of determination, in order to estimate the effect of student major choice on faculty salary.

The second part of this analysis will examine the relationship between student major choice and department hiring practices. This will use the student major enrollment dataset and the total faculty dataset, along with the corresponding percentage change values for student major enrollment and total faculty, ΔE* and ΔS, respectively. This will include data from the years 2014 to 2019 and will also produce a linear regression, correlation coefficient, and coefficient of determination in pursuit of similar information as the first part of this analysis.

Results

For the first part of the analysis, the percent change in student enrollment in each of 32 majors from 2008 to 2019 was compared with the percent change average faculty salary for the positions of Professor, Associate Professor, Assistant Professor, and Instructor in each of 32 corresponding departments, also from 2008 to 2019. A linear regression of these variables yields the equation

$$a=0.0059\varepsilon +0.2026$$

where a is the percent change in average faculty salary and ε is the percent change in student enrollment in the corresponding major from 2008 to 2019. This relationship has a correlation coefficient of $r= 0.0594$ and a coefficient of determination $r^2 = 0.0035$.

For the second part of the analysis, the percent change in student enrollment in each of the same 32 majors, this times from 2014 to 2019, was compared with the percent change in total faculty in each of the same 32 corresponding departments, also from 2014 to 2019. A linear regression of these variables yields the equation

$$\beta = -0.4288\varepsilon^* + 0.2916$$

where β is the percent change in total faculty and ε^* is the percent change in student enrollment in the corresponding major from 2014 to 2019. This relationship has a correlation coefficient of $r = -0.2120$ and a coefficient of determination $r^2 = 0.0449$.

Discussion

The results of the first part of the analysis indicate that there is virtually no correlation between changes in student major choice and faculty salaries in corresponding departments. This indicates that changes in average faculty salary for individual departments is completely dependent on other factors. This lack of correlation supports the findings of the earlier mentioned research by Goolsbee and Syverson (2019), which found that when there are one or few universities in a local area, which is the case with the University of Memphis, universities do not have to give faculty raises in response to changes in student demand.

The results of the second part of the analysis indicate that there may be a very slight negative correlation between changes in student major choice and hiring practices of corresponding departments. This indicates that departments tend to increase the student-to-faculty ratio in the face of an increase in student enrollment in the corresponding major rather than hire more teaching faculty. This lack of correlation supports the findings of the previously mentioned research of Becker, Greene, and Siedfried (2011), which suggested that faculty size is based on political drive of the institution rather than student demand. Additionally, Johnson and Turner (2009) concluded that number of faculty in a given department is due to political forces within institutions that prefer certain disciplines over others, rather than an appropriate allocation of resources, a notion which is also supported by these results.

This research could be expanded in two ways. First, the dataset could be improved by collecting data for several more universities, and over a longer span of time. This would not only reveal longer-term trends but would show if multiple universities experience similar effects as students move towards specific majors. Second, separate analyses for different teaching positions

(Professor, Instructor, etc.) could reveal relationships that are not apparent when grouping all teaching positions together, because departments face less hurdles when hiring for some positions than for others. Combining these expansions could produce results that reveal more about the relationship between student enrollment and the number of teaching faculty and their salaries.

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Appendix

Field of Study	2007-08	2017-18
Agriculture and natural resources	24,125	39,314
Architecture and related services	9,809	8,464
Area, ethnic, cultural, gender, and group studies	8,453	7,717
Biological and biomedical sciences	79,869	118,663
Business	335,495	386,201
Communication, journalism, and related programs	76,400	92,290
Communications technologies	4,654	4,231
Computer and information sciences	38,523	79,598
Education	102,849	82,621
Engineering	68,404	121,956
Engineering technologies	15,278	18,727
English language and literature/letters	55,001	40,002
Family and consumer sciences/human sciences	21,880	24,349
Foreign languages, literatures, and linguistics	20,976	16,958
Health professions and related programs	111,548	244,909
Homeland security, law enforcement, and firefighting	40,297	58,114
Legal professions and studies	3,771	4,239
Liberal arts and sciences, general studies, and humanities	46,882	44,262
Mathematics and statistics	15,169	25,256
Multi/interdisciplinary studies	34,172	51,909
Parks, recreation, leisure, and fitness studies	29,908	53,883
Philosophy and religious studies	12,259	9,603
Physical sciences and science technologies	22,164	31,542
Psychology	92,562	116,432
Public administration and social services	23,523	35,629
Social sciences and history	167,321	159,967
Theology and religious vocations	8,992	9,521
Transportation and materials moving	5,202	4,924
Visual and performing arts	87,731	88,582
Total	1,563,734	1,980,644

Table 1: Bachelor's Degrees Conferred by Postsecondary Institutions by Field of Study

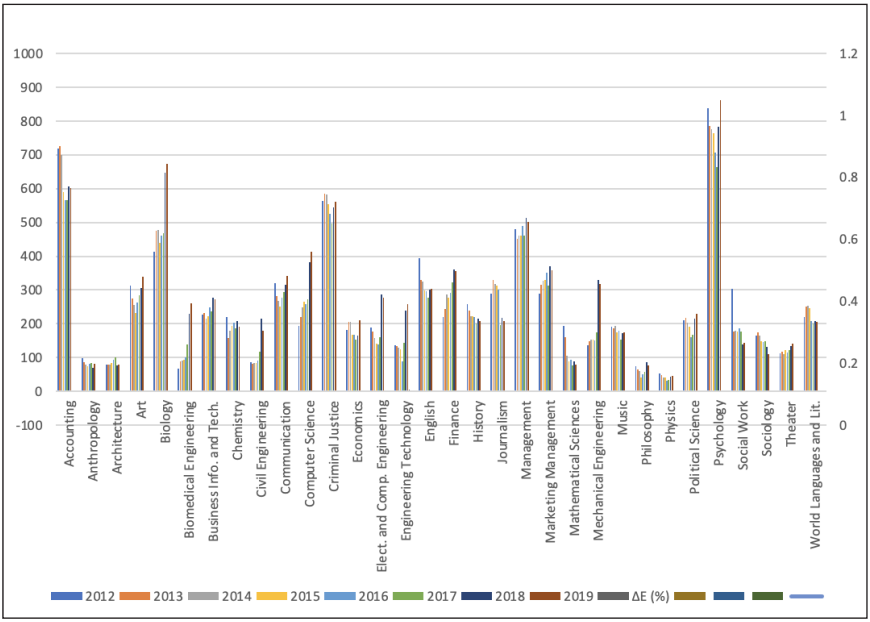

Figure 1: Enrolled Students by Major

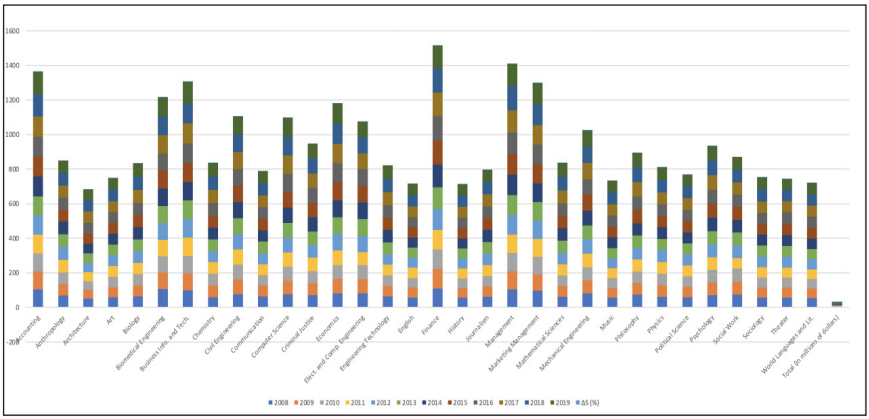

Figure 2: Average Faculty Salary by Department (in thousands of dollars)

Department	2014	2019	ΔC (%)	ΔE* (%)
Accounting	16	18	12.50%	-14.0%
Anthropology	6	11	83.33%	5.1%
Architecture	8	8	0.00%	0.0%
Art	23	24	4.35%	32.5%
Biology	28	33	17.86%	40.8%
Biomedical Engineering	9	6	-33.33%	190.0%
Business Info. and Tech.	14	12	-14.29%	27.0%
Chemistry	15	18	20.00%	7.3%
Civil Engineering	11	13	18.18%	115.7%
Communication	18	18	0.00%	28.1%
Computer Science	16	22	37.50%	66.1%
Criminal Justice	8	13	62.50%	-3.6%
Economics	11	12	9.09%	2.4%
Elect. and Comp. Engineering	11	11	0.00%	75.9%
Engineering Technology	7	9	28.57%	99.2%
English	47	56	19.15%	-6.7%
Finance	13	14	7.69%	24.8%
History	26	28	7.69%	-6.7%
Journalism	13	17	30.77%	-34.1%
Management	15	14	-6.67%	8.9%
Marketing Management	21	18	-14.29%	9.5%
Mathematical Sciences	37	39	5.41%	-24.5%
Mechanical Engineering	10	12	20.00%	108.6%
Music	41	44	7.32%	-10.3%
Philosophy	15	14	-6.67%	28.3%
Physics	11	11	0.00%	9.8%
Political Science	12	13	8.33%	13.4%
Psychology	26	30	15.38%	11.1%
Social Work	10	17	70.00%	-20.1%
Sociology	16	14	-12.50%	-34.3%
Theater	13	14	7.69%	27.9%
World Languages and Lit.	31	31	0.00%	-18.9%
Total	558	614	10.04%	14.3%

Table 2: Count of Faculty by Department

Rachel Layton grew up in both Northern Mississippi and Cologne, Germany before moving permanetly to Memphis in 2014. She graduated from the University of Memphis in May of 2020 with degrees in both German Langauge and English Literature. She will be attending the University of Missouri, Kansas City's MFA in creative fiction writing program in the Fall of 2021. She has previously been published in Memphis Magazine, Minerva Rising, and Crash Test Magazine.

Rachel's paper received a *QuaesitUM* outstanding paper award.