# An Investigation of Compensation Disparities in St. Louis Michigan


## Abstract

In this paper, we investigate if there is significant evidence for a difference in teacher compensation based on degree of education and/or level of experience for teachers in St. Louis, Michigan. We used an old data set from Socrata to explore these relationships. We hypothesize that a higher degree will correspond with a higher salary at any level of experience (≤10 or >10). Our conclusions are that while there is a visible difference between MA and BA degree compensation at all levels, the only significant difference based on degree is found in teachers in their first ten years.

## Background and Significance

Salaries, especially teacher salaries, have been extremely politicized, with the Biden administration planning to increase Title I funding for teachers (The Democrats, 2020) while Republicans in North Carolina proposed a 3.9% increase in teacher salary (the legislation was vetoed by Democratic governor Roy Cooper who deemed the raise “insufficient” (Childress, 2021)). However, these raises reportedly affect less experienced teachers more than veteran teachers. This is the case in Michigan, the state where our data originated. Salary for a less experienced (<10 years) teacher in Michigan could increase up to $21,864 over a three year period, but for a teacher of 30 or more years, salary raised only $435 over the same period (Garnet, 2019). In some states, this pay cap can be higher for teachers who have postgrad education (Childress, 2021). We are curious about the impact of postgrad education on teacher salary, as our findings could be impactful on forthcoming legislation. We hypothesize that a teacher with a Master’s degree earns significantly more than a teacher with a Bachelor’s degree at any level of experience.

## Methods

### *Data Collection and Variables*

Our data set is a census of 71 teachers in the St. Louis, Michigan school district for the 2009-2010 school year. The information was originally posted on socrata.com, a site used exclusively by government agencies to provide data it has collected to the public. However, the dataset is no longer available from Socrata - it was presumably taken down ten years after it was posted. We accessed the dataset through openintro.org and as such have little information on how our data was collected. The data has information on education level (BA or MA), employment status (Full-time or part-time), years of employment experience (# of years), base salary ($), FICA contribution ($), retirement contribution ($), and total salary (base + FICA + retirement, in $). We decided to look at education, experience, and total salary as our key variables, as they were relevant to our research question and hypothesis.

### *Exploratory Data Analysis*

From the original dataset, we deemed one observation to be beyond the scope of our project, a teacher who only taught part-time. As we are only interested in full time teacher salaries, we filtered out this observation from our exploration and analysis. We then created four categories, breaking observations into groups by degree and experience (Appendix 1). For the purposes of our investigations, we are looking at both base salary and retirement variables by using the total salary variable, which shall henceforth be referred to as “compensation”. We feel that this is the best approach because retirement benefits are typically part of hiring negotiations - some employees may prefer a higher retirement compensation while some may prefer a higher salary compensation. Taking into account only one or the other would fail to account for this confounding variable.

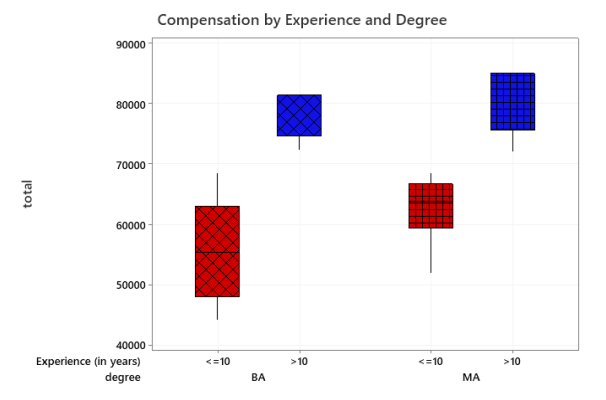


**Figure 1:**

Using these four categories, we summarized salaries of teachers based on degree and level of education in a box plot here. This graph shows a visual difference in median compensation between teachers with ≤10 and >10 years of experience and between teachers with a Bachelor's degree (BA) and a Master's degree (MA). Immediately, we can see that there is a large difference between salaries at low experience levels but a much smaller difference at higher experience levels.

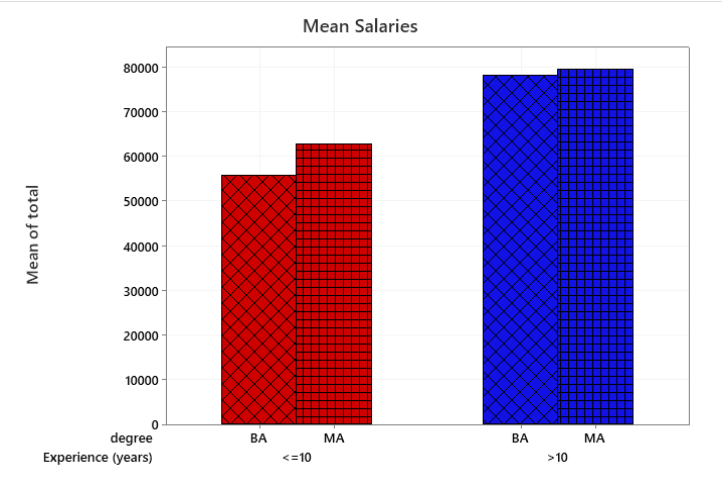


**Figure 2:**

We found it useful to visualize the means in bar chart form as well, to clearly demonstrate the much larger difference of mean in the group with less experience (Appendix 2).

***Analytic Methods***

We first ran a Test for Equal Variance (Appendix 3) in the hopes that we could run ANOVA. However, we found significantly different levels of variance. This disqualifies us from running ANOVA. This demonstrates that there is a larger range of variance for teachers early in their career, especially those only holding a BA. We then used our calculated means in order to run multiple one-sided 2 sample t-tests which compare the effect of degree at the two different experience levels given the drastic difference displayed in Figures 1 and 2. Because we were running multiple comparisons, we used the Bonferroni correction to find a stricter significance level, finding our new confidence level to be 99.375% instead of 95% (Appendix 5).

The first t-test we ran compared the difference in mean compensation between all low experience teachers and all high experience teachers (Appendix 4). We ran this test to determine if there is indeed a significant raise in compensation as experience increases. The second t-test we ran compared the mean compensation of all teachers with a BA and all teachers with an MA (Appendix 4). We ran this test to determine if there is a significant difference in mean compensation between BA and MA degrees. The third t-test we ran compared the difference in mean compensation of low experience teachers with a BA to low experience teachers with an MA (Appendix 4). The fourth t-test we ran compared the difference in mean compensation of high experience teachers with a BA to high experience teachers with an MA (Appendix 4). We considered running a linear regression to better observe the effect of each variable, but found that our data does not have constant variability and thus does not meet the requirements to use it ethically (Appendix 6).

## Results

The first t-test found that there is a mean difference of $19,360, with a Lower Bound for Difference at $15,080. This provides significant evidence that teachers with high experience earn significantly more than teachers with low experience. This difference is also practical, as the mean difference is $19,360. The second t-test found that there is a mean difference of $1,915, with a Lower Bound for Difference at -$4,486. This does not provide significant evidence that teachers with an MA have a higher mean compensation than teachers with a BA. The third t test found that there is a mean difference of $7,012, with a Lower Bound for Difference at -$375. This does not provide significant evidence that low experience teachers with an MA earn significantly more than low experience teachers with a BA. The fourth t test found that there is a mean difference of $1,478, with a Lower Bound for Difference at -$2,336. This does not provide significant evidence that teachers with high experience and an MA earn significantly more than teachers with high experience and a BA (See appendix 4).

## Discussion

We predicted that an MA would ensure higher compensation at any experience level. We are shocked to find that this was not the case. We do want to caution that we found high variance and there is still a large difference in means, notable discoveries that may call for further extensive data collection. It is also notable that with our original significance level of 0.05%, test 3 would have passed, but since it does not meet our stricter significance level, we do not have enough evidence to accept it as statistically significant.

These findings should be useful as we have discovered that the legislation which invokes increased year-to-year raises would disproportionately affect less experienced teachers while legislation which invokes an immediate bump (either a set amount or a percentage) would benefit all teachers regardless of experience. While we cannot use this observational study to make any conclusions, we would like to provide potential explanations for the results. Regarding teachers with a BA starting at a much lower compensation, they may have a gap in their knowledge that an MA holder does not. Perhaps the knowledge that can be gained in a few years obtaining an MA can be obtained through practice in the field, albeit more slowly. We believe that the lack of significant difference between groups of highly experienced teachers is due to a compensation cap which is not significantly higher for those with postgrad education.

A key limitation to our data is the lack of background information. While we know that it was posted by a government agency, presumably by either the St. Louis Public Schools or the Michigan Education Department, we do not know why this study was done or why this data was released to the public. Per our research, we have found that there is a pattern of freedom of information requests involving teacher compensation as it becomes an increasingly political issue. One final conclusion that can be made is that while a postgrad education may lead to a higher salary as a less experienced teacher in the St. Louis school district, it will not lead to higher compensation in the long run (over 10 years), and thus, if maximum compensation for minimum expenses is one’s goal, postgrad education may not be worth the time and money if one intends to become a teacher.

## References


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**Appendix 1**

We quantified the number of observations in each of the four categories for the purpose of demonstrating that the sample sizes exceed 10 in each of the four categories, thus being large enough to support our analysis.

**Table 1**

| | BA | MA |
|---|---|---|
| 10 or less years | 14 | 14 |
| More than 10 years | 25 | 17 |

**Appendix 2**

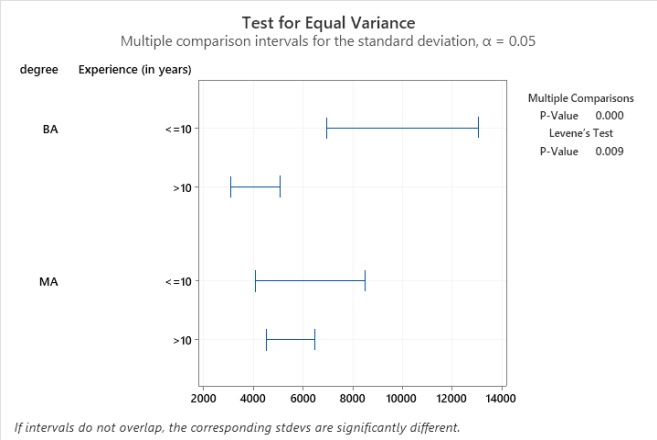
We calculated the mean salaries for each of the four groups for the purpose of comparing means to determine if there is a significant difference. It appears that there is a much larger difference between salaries based on degree early in teaching careers rather than late in teaching careers.

**Table 2**

| | BA | MA |
|---|---|---|
| 10 or less years | $55,816.50 | $62,828.20 |
| More than 10 years | $78,084.30 | $79,562.70 |

**Appendix 3**

We ran an ANOVA test for equal variance to determine eligibility for an ANOVA test. The data failed the test and so the conditions for ANOVA are not met.




**Appendix 4**

The detailed results for the one sided t-tests are listed below. We switched the sign of all results to comply with our hypothesis.

## Descriptive Statistics: total

| years_1 | N | Mean | StDev | SE Mean |
|---|---|---|---|---|
| 0 | 28 | 59322 | 7877 | 1489 |
| 1 | 42 | 78683 | 4306 | 664 |

## Estimation for Difference

| Difference | 99.375% Upper Bound for Difference |
|---|---|
| -19360 | -15080 |

1st: ≤10 exp vs >10 exp

## Descriptive Statistics: total

| degree | N | Mean | StDev | SE Mean |
|---|---|---|---|---|
| 1 | 39 | 70091 | 12303 | 1970 |
| 2 | 31 | 72005 | 9861 | 1771 |

## Estimation for Difference

| Difference | 99.375% Upper Bound for Difference |
|---|---|
| -1915 | 4886 |

2nd: All exp BA vs MA

## Descriptive Statistics: total

| degree | N | Mean | StDev | SE Mean |
|---|---|---|---|---|
| 1 | 14 | 55816 | 8605 | 2300 |
| 2 | 14 | 62828 | 5324 | 1423 |

## Estimation for Difference

| Difference | 99.375% Upper Bound for Difference |
|---|---|
| -7012 | 375 |

3rd: ≤10 exp BA vs MA

## Descriptive Statistics: total

| degree | N | Mean | StDev | SE Mean |
|---|---|---|---|---|
| 1 | 25 | 78084 | 3758 | 752 |
| 2 | 17 | 79563 | 4994 | 1211 |

## Estimation for Difference

| Difference | 99.375% Upper Bound for Difference |
|---|---|
| -1478 | 2336 |

4th: >10 yrs exp BA vs MA

**Appendix 5**

Bonferroni Correction Calculations: new $\alpha$ is $\frac{\alpha}{2k}$

K is the number of comparisons, 4.

$\frac{0.05}{2(4)} = 0.00625$

P value must be <0.00625 for us to reject the null hypothesis that there is not a significant difference

T-score calculation: $\frac{Observed\ Difference - null\ value\ (0)}{Standard\ Error}$

Difference (BA-MA then High exp-Low exp)

Test1 = 19360, Test2 = 1915, Test3 = 7012, Test 4 = 1478

SE = $\sqrt{\frac{SD_1^2}{n_1} + \frac{SD_2^2}{n_2}}$

Test1 = 1630.16, Test2 = 2649.13, Test3 = 2704.37, Test4 = 1425.47

T-score

Test1 = 11.876, Test2 = 0.7229, Test3 = 2.5928, Test4 = 1.0369

P-value (derived using online calculator that uses t-score and DF. Is one-tailed because we claim that one would be greater than the other)

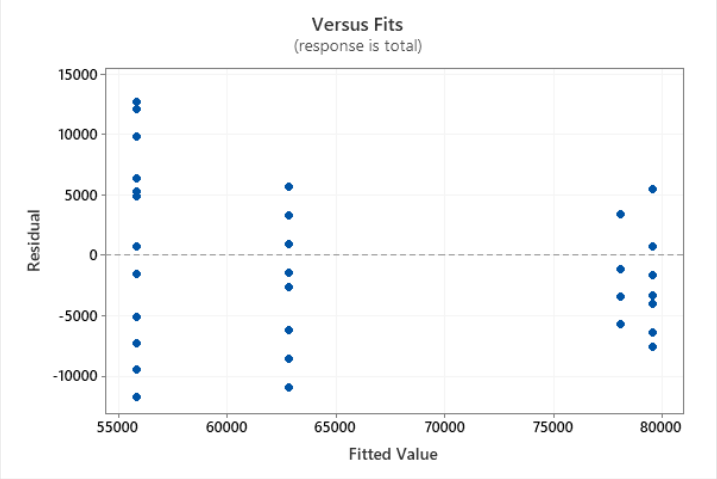
Test1 = <.00001, Test2 = .2377, Test3 = .01115, Test4 = .1576

Degrees of Freedom = minimum of two sample sizes minus 1

Test1 = 27, Test2 = 30, Test3 = 13, Test4 = 16

Hypothesis test and p-value finds Tests 1 and 3 significant at 5% significance, but according to Bonferroni Correction, only Test 1 is significant. This is visible in our confidence interval as test 3's lower bound is very close to 0, within 1 standard error distance.

## Appendix 6




We can see from this residual vs fits graph that our data does not have constant variability between groups, so we will not be able to use fitted regression.