THE OPPORTUNITY COST OF TEACHING

FOR SECONDARY STEM INSTRUCTORS

A Doctoral Thesis Presented to the

Faculty of the College of Education

University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Education

by

Anthony Joseph LiVecchi

December 2017

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Abstract

Many school districts across the United States face severe shortages of high school science and mathematics teachers. Moreover, college graduates that major in a Science, Technology, Engineering, or Mathematics (STEM) field face unique opportunity costs when deciding to enter the teaching field. An analysis of the opportunity costs faced by STEM majors between teaching and non-teaching careers may offer superintendents and principals an insight into the decision making process of STEM majors. Through this understanding, school districts may be able to reduce the shortage of mathematics and science teachers they face annually. This mixed-method study utilizes the following two research methods: the archival research method and semi-structured interviews. The data sources included for salary information are the National Association of College and Employer (NACE) survey data on STEM major starting salaries from 2009 to 2017, and the Bureau of Labor Statistics (BLS) Occupational Outlook Handbook (OOH) survey data on median salaries for STEM majors from 2009 to 2017. The first analysis will include creating linear plots for 10-month adjusted salary for STEM teachers and non-teachers. Salary differentials will be expressed in dollars. The second analysis through semi-structured interviews will gather input and insight on why STEM majors enter and stay in teaching. The results indicate that all STEM majors earn higher salaries than STEM educators at all experience levels, with the exception of first year salaries of Science majors. The interview data indicated that teachers with STEM majors work in education because of the interaction with students. While wage differentials may turn potential teachers away from careers in education, once an individual commits to education the ability to work with students keeps them in the classroom.

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Chapter 1

Introduction

The idea that teachers are underpaid is not a new concept either in news media or academic research. The conventional wisdom about teacher salaries indicates that if one wants to make money in a career, education is not a viable career choice. Some policy makers are even stating that teacher salaries should be raised up to $120,000 per year in an effort to retain and attract top teachers to the profession (Strauss, 2014). The mindset over teacher salaries in comparison to other professional salaries is evidenced by the following example:

> “A number of policy makers and high-profile reports have made the recommendation to raise teacher salaries. This is consistent with a widespread perception that teachers are poorly paid and have lost ground economically when compared with those employed in other occupations.” (Goldhaber & Player, 2005, p. 211)

In 2013, former Secretary of Education under the Obama Administration, Arne Duncan, stated, “We should be paying teachers a lot more money … having a great teacher making $130,000, $140,000, $150,000.” (Burns, 2013) This statement expresses the connection to conventional wisdom; however, it does contradict a report by Greene and Winters (2007) that the conventional wisdom may not be correct.

In an effort to identify why the public perception exists that educators are not as well paid as other white-collar or professional workers, Greene and Winters (2007) determined that part of the lower salary for teachers is to make up for a shorter work year.

They also argued that professional employees besides teachers work outside of their traditional hours:

> “This objection is not very compelling. First the National Compensation Survey is designed to capture all hours actually worked. And teachers are hardly the only wage earners who take work home with them.” (Greene & Winters, 2007, p. A19)

Greene and Winters (2007) compared teacher salaries to other professional salaries on an hourly basis. They found that teachers earn, nationwide on-average, $34.06 per hour. This figure is derived from factoring in summer vacation and time-off for school breaks during the year. While comparing teacher salaries on an annual basis to other professional employees indicates lower salaries, comparing on an hourly basis paints a more equitable picture between teachers and other professional’s earnings. Moreover, they did not discuss the value of pensions or post-career income and job security as part of the trade-off for lower present day salary.

The argument laid out by Greene and Winters (2007) was further supported by Goldhaber and Player (2005):

> One difficulty in comparing teaching with competing occupations is finding a standard measure of compensation. Teachers typically work 10 months, whereas non-teachers usually work 12 months, which makes it difficult to directly compare pay in teaching and non-teaching jobs (p.217).

Goldhaber and Player (2005) developed a method to more adequately compare salaries across teaching and non-teaching professions. This analysis reviewed starting salary ratios for teaching to other professions. The data showed that teachers had a lower salary ratio when compared to careers including the following Science, Technology, Engineering, and Mathematics (STEM) occupations: engineering, statistics, accounting, mathematics, chemistry, and computer science. The problem with the ratio is that the authors utilized annual salaries for their analysis, and defended that choice by indicating:

> "In practice, when focusing on the relative attractiveness of teaching over time by comparing teacher salaries with those in other occupations, the annual versus hourly debate is irrelevant because the relative changes are not affected by the metric chosen as long as one is consistent in the comparison used." (p.217)

Teaching as an entire profession generally does not differentiate salary based on the subject or grade level taught. However, based on what a teacher specializes in can determine opportunities to earn wages outside education. For example, an elementary teacher or special education teacher may have limited ways to earn money outside of education. Whereas a STEM teacher could take a job in various alternative industries, based on their degree in a science, technology, engineering, or mathematics major.

STEM teachers also have the ability to earn supplemental wages during the course of the school year and in the summer. They can earn money tutoring, freelance technical writing, summer bookkeeping, teaching summer school, and through various other professional opportunities. Therefore, the annual salary for a STEM teacher may not necessarily equal to their teaching salary alone as there are multiple ways to enhance their salary through alternative short-term opportunities.

Rationale for the Study

Low salaries for teachers are often considered a problem in recruiting and retaining the most talented educators (Rickman, et.al, 2016; Goldhaber & Player, 2005; Silber, 1998; Wolfson, 1948). The perception exists that teachers are often paid less than those with similar education. Rickman et.al (2016) reviewed the relative salaries of STEM majors and their decision to teach. A stated concern included:

> "The disparities in teacher pay may lead to difficulties in attracting and retaining teachers in states with the lowest pay, especially where teachers are paid relatively worse than college-educated workers in other occupations." (Rickman, et.al, 2016, p.1)

For STEM educators an intriguing questions arises as to the opportunity cost of pursuing teaching as a career rather than an industry field that requires the same qualifications. What level of salary is compromised if an individual chooses to teach high school physics, for example, instead of becoming an engineer?

In order to answer this question, the opportunity cost of teaching STEM rather than choosing an alternative STEM career must be determined. The requirements to have a STEM career inside and outside of education are similar, with education careers requiring a teaching certificate in addition to whatever major course work is required by the degree granting institution. Studying the opportunity cost of a career in STEM education rather than a non-teaching STEM profession can be analyzed by reviewing salary differentials between these two professional tracks.

Current research, although limited in number of studies, shows that the salary differentials between STEM teachers and STEM non-teachers may be a strong factor for STEM graduates to choose an alternative to teaching. A recent study by Chingos and West (2013) indicated the following:

> "Unfortunately, the same labor-market trends that have made math and science skills increasingly valuable to students may make it increasingly difficult to

> attract teachers with the talent and training necessary to address the challenge. Despite a recent wave of reform, the vast majority of school districts nationwide continue to pay teachers based on salary schedules that fail to differentiate among teachers based on their subject-area expertise. To the extent that teachers with technical skills have better earnings opportunities in other industries, this approach can be expected to produce fewer – perhaps even a shortage – of qualified candidates for math and science teaching jobs." (p. 2)

Furthermore, a focus on teacher shortages within mathematics and science disciplines in K-12 schools reviewed the reasons the teaching field cannot attract top talent into classrooms (Ingersoll & May, 2012; National Resource Council, 2002; National Academy of Sciences, 2007). Ingersoll and May (2012) studied the turnover and paths of employment for mathematics and science teachers. Perez, Cromley and Kaplan (2014) study the attrition rate of STEM majors in college and find that in some cases 40% of STEM declared majors end up graduating outside of a STEM major, impacting the volume of overall STEM majors from college (Perez et al., 2014). This is significant in determining the shortage of STEM teachers overall in the education system and in the labor market as a whole.

Supporting research to salary differentials include understanding why teachers, including STEM teachers, leave teaching in the first place. Research about teacher attrition (Hanushek, Kain, & Rivkin, 2001; Ondrich, Pas, & Yinger, 2008; Goldhaber, Gross, & Player, 2011) indicate that teacher attrition is a problem in producing positive educational outcomes. For example:

> "If the goal is to maximize the number of highly effective teachers staying in the system and staying in schools that most need them…some of the hard debates about teacher pay and incentives, are worth having. The policy community will be well served by research that focuses specifically on the relationship among these issues." (Goldhaber, et.al, 2011, p. 83)

A review of current research shows the problem of teacher attrition, not only among STEM teachers but all teachers, as a serious issue that merits policy analysis and investigation. However, research measuring the opportunity cost for STEM teachers is not current. There is a need for a current analysis that measures opportunity cost of teaching STEM in public schools.

A study conducted by Murnane and Olsen (1989) reviewed longitudinal data to determine the opportunity costs teachers and potential teachers face when choosing teaching as a career choice. The study reviewed career histories of nearly 14,000 public school teachers in North Carolina. The results indicated that salary has an impact on the length of time teachers remain in the field, especially for new teachers, and that teachers with higher opportunity costs for teaching do not stay in the classroom for as long as teachers that face lower opportunity costs.

Conceptual Framework: Opportunity Cost

This study will investigate the opportunity cost of employment in a STEM teaching position rather than a non-teaching STEM career. Opportunity cost is nestled in the economic understanding of scarcity. Economics is the study of how individuals make choices, with the discipline accepting that individuals make those choices to maximize utility, with the reality of limited resources. Opportunity cost is value of what you must give up when you make a particular choice (Ray & Anderson, 2011). Therefore, the opportunity cost of choosing one particular career is the value of the alternative next best choice. For example, if an individual had the credentials to be chemistry teacher, meaning they had the required course work and state certificate to teach, and the credentials to work as a chemist for a private firm, that individual would conduct an individual economic analysis to determine which choice is their best choice.

This study will focus on that choice with the understanding that salary can help measure opportunity cost for an individual. In the above example, if the salary for a teacher was $40,000 and the salary for a chemist was $42,000 the opportunity cost of being a teacher would be $42,000 or the salary lost by not being a chemist. Analysis of the alternative would mean the opportunity cost of being a chemist, and not choosing teaching, would be $40,000. A rational individual, with all other aspects of each career being equal, would choose to be a chemist because the opportunity cost of being a chemist, the lost $40,000 salary of being a teacher, is lower than the $42,000 that would be forgone if the individual chose to teach.

A review of the literature identifies gaps in the existing body of knowledge relating to the opportunity cost of choosing a STEM education career versus a non-teaching STEM career, which is further discussed in Chapter 2. Researchers have examined teacher salaries and trends in teacher salaries, STEM teacher salaries, STEM non-teacher salaries, salaries in general for all employees, and career opportunity costs. However, none of the studies reviewed national-level data on opportunity costs for entering the STEM teaching field. STEM teaching and STEM non-teaching careers have similar educational requirements and preparation steps. Determining the opportunity cost of teaching in a STEM field will help students when thinking about their future career choices when they have a STEM degree. Policymakers and school districts can benefit from understanding the salary structures of STEM majors in education and out of education. Utilization of national salary data in the analysis of wage differentials for STEM teaching versus STEM non-teaching careers may help determine if STEM teachers are underpaid in comparison to STEM non-teachers.

Statement of the Problem

This study is designed to determine the opportunity cost, in terms of salary, by comparing STEM teacher salaries with non-teaching STEM career salaries, for individuals with similar levels of education. Median salaries, as reported in the 2015 *Occupational Outlook Handbook* published by the Bureau of Labor Statistics (BLS), reported that on an annual basis, salaries for secondary teachers (grades 9-12), career and technology secondary teachers, different types of science professions, technology professions, engineering professions, and mathematics professions. These data are presented in Table 1, with listings of each profession and explanation of conglomerated professions.

Table 1

Median Salaries, 2015, by Type of STEM Career, with similar minimum education required.

Occupation	Median Salary
Teacher, Secondary	$57,200
Teacher, Secondary, Career and Technology	$52,800
Science[1]	$70,418
Technology[2]	$89,953
Engineering[3]	$94,167
Mathematics[4]	$75,135

Notes: *1. Science careers include the following: Chemist, Environmental Scientist, Zoologist, Hydrologist, Material Scientist 2. Technology careers include the following: Database administrator, Network and Computer Systems Administrator, Software Applications Developer, Network Architects 3. Engineering careers include the following: Biomedical engineers, Chemical Engineers, Civil Engineers, Electrical Engineers, Environmental Engineers, Mechanical Engineers, Petroleum Engineers 4. Mathematics careers include the following: Actuaries, Financial Analysts, Accountants and Auditors, Budget Analysts, Cost Estimators, Logisticians Source: Occupational Outlook Handbook*, by Bureau of Labor Statistics, 2017, Washington, DC: Author.

Median salaries published by the BLS, reported on an annual basis, show that secondary teachers are paid less than people employed in STEM non-teaching careers. As shown in Table 1, secondary teachers median salaries were lower than mean of the median salaries of all STEM non-teaching professions. Determining the opportunity cost of teaching high school STEM classes rather than entering a non-teaching STEM career with similar education requirements, can provide empirical evidence to determine whether and to what extend teachers are paid less than others with similar qualifications.

The results of this study may determine whether and to what extent STEM teachers are paid less than non-teaching STEM professionals, with similar educational backgrounds.

Research Questions

This study is guided by the following research questions:

1. Is there is a difference between starting STEM teaching salaries and starting STEM non-teaching salaries?

2. What is the opportunity cost of choosing to be a high school STEM teacher, as measured by (a) the comparison of initial salary of new STEM teachers and non-teaching STEM professionals upon the completion of an undergraduate degree, and (b) median salaries of STEM teachers and non-teaching STEM professionals at all levels of education and experience?

These research questions address two salary groupings: (a) starting salaries of newly graduated holders of bachelor's degrees, and (b) median salary data for all professionals in selected occupations.

3. What is the rationale for staying in teaching and how is individual opportunity cost measured? This will be evaluated by interviewing current high school STEM credentialed teachers and analyzing their responses to a semi-structured interview.

Research Design

This is a mixed method study will utilize the archival research method and semi-structured interviews of current STEM teachers. Archival research methodology is focuses on (a) an examination of primary documents, and (b) ex post facto examination of recorded information (Pearce-Moses, 2005). Archival research involves reviewing studies performed by other researchers or by analyzing historical, existing data, but not in generating new data for analysis. Advantages of archival research include the following: (a) researcher influences on research subjects is eliminated; (b) archival data can produce hardy insights of trends, correlations, and results, and; (c) information and data is easily accessible and available to the public (Cherry, 2016).

Archival research methodology has the following disadvantages: (a) the researcher has little control over the design of data collection; (b) timing and specificity of the data is out of control of the researcher; and (c) there is a lack of quality control on the part of the researcher in the collection methods of the data (Cherry, 2016).

Moreover, the qualitative method of research will consist of a semi-structured interview with STEM bachelor degree holders that are current high school science teachers. The semi-structured interview is a combination of structured questions and unstructured spur of the moment questions. However, the largest part of the interview is based on a list of guiding questions asked to all interview subjects (Merriam, et.al, 2002). The purpose of using a semi-structured format is that this format allows for more openness and individual response from interviewees when trying to determine their opportunity cost of teaching.

National salary estimated compiled and published by widely available sources will be investigated and used to develop further analyses in addressing the research question. Sources of starting salaries at the bachelor’s degree level, median salaries, and analysis techniques are discussed in the following section

Starting Salaries

A data source compiling salary information was produced by the National Association of Colleges and Employers (NACE) and it was used to examine and develop further analysis of the research question. The datasets include starting salaries for recent college graduates at various levels of education by college major subject. For this study, only salaries for bachelor's degrees will be analyzed, utilizing the Fall NACE reports from 2009 to 2017. Table 2 presents examples of bachelor degree and starting salary for specific majors.

Median Salaries

Another source of data is collected by the BLS and is published in the *Occupational Outlook Handbook*, utilizing national salary surveys conducted by the same agency. The *Handbook* reports hundreds of occupations in multiple industries. The salaries reported in the *Handbook* are aggregate salaries at different career points for individual respondents. Whereas the *NACE* reports only starting salaries, the *Handbook* reports salaries at the beginning, middle, end, and everywhere in between of a profession. The BLS median salary data is useful for measuring salaries for individuals employed within a profession regardless of educational attainment, experience, or other factors that may affect salary.

Comparison between the two data sets, *NACE* data and *Handbook* data respectively, is fairly straightforward as evidenced in Table 3. While *NACE* occupations are broader categories and *Handbook* data is job specific, STEM careers tend to align with college majors fairly well. Detailed discussion about the data, data sources, and software systems used to analyze the data will be discussed at length in Chapter 3.

Analysis Techniques

Salary differences between STEM teaching and STEM non-teaching positions will be measured for differences in median salary levels to determine if salary differences exist between teachers and non-teachers in the STEM field by analyzing starting salaries of bachelor’s degree holders and median salaries of STEM teaching and non-teaching STEM professionals.

Table 2

Reported STEM and Education Majors at the Bachelor Degree Level Present in the National Association of Colleges and Employers (NACE) Report

Education Majors	STEM Majors
Elementary Education	Science
	Biology, Chemistry, Environmental
Secondary Education*	Science, Geology, Physics
	Technology
Special Education	Computer science, Information systems
	Software applications
	Engineering
	Aerospace, Biomedical, Chemical
	Civil, Computer, Electrical
	Materials
	Nuclear
	Petroleum
** Secondary education majors require a*	Mathematics
conjoined major. Examples include:	Mathematics
Math, Science, History, English, etc.	Statistics
	Accounting

Source: “NACE Salary Survey: A study of 2015-2016 beginning offers,” by National Association of Colleges and Employers, 2016, *National Association of Colleges and Employers, p. 9, 2016*

Purpose of the Study

This study is primarily focused on determining the opportunity cost, in terms of salary differentials, between employment in STEM teaching careers versus STEM non-teaching careers, where both career paths have similar educational requirements: a bachelor's degree in a STEM field. This archival study will compare the salary differentials in order to determine if STEM teachers are paid less than STEM non-teachers with similar education backgrounds. Knowing the salary differentials between STEM teachers and STEM non-teachers is helpful in determining the opportunity cost of teaching STEM, and forgoing a career in a non-teaching STEM field.

To determine the opportunity cost of STEM teaching, careers with similar educational requirements in STEM fields were identified based on minimal educational requirements. Non-teaching careers that required less than a bachelor's degree will be omitted from the study, as will careers that require higher levels of education, such as a master's degree or a doctoral degree. A qualitative screening process will be utilized to compare STEM teacher salaries to the salaries of non-teaching STEM careers that align with the careers included in the NACE report to ensure that the salaries that are reported align with the educational requirement expectations of the career.

Significance

College graduates who are contemplating entering the STEM teaching field or entering a non-teaching STEM career need to have accurate information regarding the opportunity cost of a teaching position in STEM. Many policymakers, college advisors, and guidance counselors may not be aware of teaching salaries at the beginning and median levels when compared with salaries for other professions, requiring similar education levels. This study will provide an analysis into the opportunity cost of a career as a STEM teacher, in terms of salary differentials, compared to a non-teaching STEM career.

A need exists for a study comparing opportunity cost, in terms of salary, for STEM teachers and non-teacher STEM careers that require a similar level of education and skill on a national level. A more specific way to test the opportunity cost is to examine teachers of a particular subject and non-teaching professionals with similar levels of education in jobs requiring similar content knowledge. This study is designed to determine the opportunity cost of choosing to teach a STEM discipline instead of choosing a STEM career that is non-teaching. The results of this study will provide data to inform education policy makers, STEM majors, and college guidance counselors, as well as the public, with accurate information on the opportunity cost, in terms of salary, for teaching in a STEM field.

Definition of Terms

Key terms are defined for the purpose of this study:

Archival Research: Archival research methodology focuses on (a) an examination of primary documents, and (b) ex post facto examination of recorded information (Pearce-Moses, 2005).

Opportunity Cost: Opportunity cost is value of what you must give up when you make a particular choice (Ray & Anderson, 2011).

Organization of Thesis

This study is organized in the following manner: Chapter one presents an overview to the problem of evaluating the opportunity cost of STEM teaching, in terms of salary, in comparison to a non-teaching STEM career, and a rationale for the study. Chapter two is a review of the literature for teacher salaries, STEM career salaries, opportunity cost, career choice, and teaching as a career choice. Chapter three presents the methods and a description of the data, data collection procedures, data analysis procedures, and limitations of the study. Chapter four presents the results of the analysis of the collected data. Chapter five summarizes the study, discusses the study results and expresses conclusions from the study results.

Table 3

Matched Salary Groups Between Median Salary Occupations According to the National Association of Colleges and Employers (NACE), National Center for Educational Statistics (NCES), and the Bureau of Labor Statistics (BLS)

NACE/NCES Category	BLS Occupational Job Title
Secondary Education	Teacher, Secondary Teacher, Secondary, Career and Technology
Chemistry	Chemist
Environmental Science	Environmental Scientist
Geology	Geologist
Physics	Hydrologist
Accounting	Accountant
Mathematics	Mathematician
Statistics	Statistician
Biomedical, Chemical, Civil, Electrical, Materials, Mechanical, Petroleum Engineering	Engineer (Biomedical, Chemical, Civil, Electrical, Material, Mechanical, Petroleum)
Computer Science	Computer Scientist
Information Systems	Information and Network Administrator
Software Applications	Software Application Administrator

Note: Derived from the January 2016 NACE Salary Survey Report. BLS occupations were selected based on occupational job descriptions published in the yearly BLS Occupational Outlook Handbook for 2015.

Chapter 2

Literature Review

The idea that teachers are underpaid is not a new concept either in news media or academic research. The conventional wisdom about teacher salaries indicate that if one wants to make money in a career, that education is not a viable career choice to meet lofty salary goals. Some policy makers are even stating that teacher salaries should be raised up to $120,000 per year in an effort to retain and attract top teachers to the profession (Strauss, 2014). The perception of low teacher salary is often cited as a reason public schools are not able to retain top talent in classrooms:

> "Yes, if you love something you should do it regardless of pay, but when you take into consideration the time, the effort, the emotional toll and what teachers are asked to *actually* do *every day*, it was painfully obvious that teaching is not a sustainable job." (Riggs, 2013, p. 3)

While many researchers have looked into the idea of teacher pay and how to attract and retain talented teachers based on pay and pay scales very little literature exists on the opportunity cost faced by teachers, specifically Science, Technology, Engineering, and Mathematics (STEM) teachers, when choosing a career path. Opportunity cost is defined as the value of what you must give up when you make a particular choice (Ray & Anderson, 2011). The idea of opportunity cost is an essential point to understand for individuals who are choosing a career path. Because subject requirements for STEM graduates, whether they choose to go into teaching or non-teaching STEM careers, are similar the opportunity cost of choosing to be a STEM teacher is the differential between a STEM teaching salary and the salary for a non-teaching STEM career.

Low teacher salaries are often cited as an issue in education literature effecting everything from retention (Hanushek, 2004; Ingersoll, 2012; Ondrich, 2008), recruitment (Henry; 2012) and teacher quality (Rockoff, 2004; Mincu, 2015) among other topics and categories. The question this study attempts to answer is what does an individual give up or forgo, in terms of lost salary, when they choose teaching over another career, specifically those with a STEM major. Providing an analysis of this question can help both policy makers and future educators make decisions. Policy makers will be aided by understanding the alternatives to teaching and how to shape aspects of teaching: salary, mentorship, work schedules, and other factors. Potential future educators can benefit by understanding the opportunity costs of their career decisions.

The review of literature for this study relates to the following areas of research: teachers' salaries'; teacher attrition, retention, and recruitment practices; opportunity cost; and both teaching and non-teaching career choice.

Teachers' Salaries

The public perception is that teachers are underpaid compared to other bachelor degreed workers. According to a recent Education Next article (Kerstetter, 2016) 65% of the public believes teachers should receive an increase in salary. However, only 41% of respondents agreed that teachers should receive a salary increase when informed of the salary a teacher makes in their community. Two-thirds of respondents agree that teachers should be paid more, and once informed of teacher salary, two-thirds of those respondents still agree that teachers should realize salary increases. There is a portion of the public that is fixed in the mindset that teachers must earn more money, regardless of the facts of current teacher salaries.

The idea that teachers are underpaid must come from somewhere. Salary analysis is conducted through multiple methods by the United States government. Through the Bureau of Labor Statistics, the US Census Bureau, and other agencies, multiple reports and analyses of worker income and employment rates exist. An analysis of teacher salaries was conducted to determine wage differentials for teachers and non-teachers with similar education backgrounds (Taylor, 2008). The analysis reviewed census data from 2000 and consisted of salary data for over 970,000 employed, college-educated workers in over 460 occupations. It was noted that some occupations were more similar to teaching than other occupations, the researched reported that teachers work an average of 42.8 hours per week and non-teachers worked an average of 44.4 hours per week. Moreover, teachers worked just over 44 weeks per year, while non-teachers worked just over 50 weeks per year. The researcher concluded that this difference in hours and weeks worked did not account for all salary differences between teaching and non-teaching professions. Rather, geographic locations of teachers and non-teaching professionals attributed to salary differences. Overall, Taylor concluded that teacher salaries are 15% lower because of time not worked during the summer months.

Arguments are made in research and in popular media that low teacher salaries can create teacher shortages. As wages are an incentive to work, if a wage is below the market value for that position, labor shortages may exist. All teachers are limited by the single salary schedule, the most prevalent method of determining public school teacher salary. Recent research shows that offering differentiated pay scales for STEM teacher may in fact limit the issue of teacher shortages in hard to staff areas by helping to retain skilled teachers in STEM areas and by inducing more pre-service STEM teachers to seek certification in STEM teaching (Goldhaber, et.al, 2014). Differentiating salary for STEM teachers, inducing participation in the STEM teacher labor market, is akin to adjusting the opportunity cost of not teaching STEM.

In general, public school teachers require a bachelor’s degree to gain certification to teach in the United States with limited exceptions. Comparing teaching salaries and work conditions to other professions that require a bachelor’s degree sheds light on the state of teaching salaries to the rest of the educated workforce in the United States. Researchers concluded that wages of teachers, in comparison to salaries of other college graduates, have fallen since 1940 (Hanusheck and Rivkin, 2007). The researchers tracked changes in teachers’ salaries compared to salaries of individuals holding a bachelor’s degree and participating in the work force. They found that teachers earned more than bachelor’s degreed non-teachers on average. There was no delineation for STEM teachers and non-STEM teachers which would have contributed more to my study’s purpose.

Comparing the salary of teachers with non-teaching bachelor’s degreed members of the workforce is a challenging task because of the nature of the schedule of a teacher’s work year. Most careers are based on a 12-month schedule, with two-weeks of paid vacation, which equates to a 50-week work year. However, teachers tend to work either nine or 10 months during the year (Podgursky & Tongrut, 2006). When data was compared on weekly earning basis, rather than an annual basis, comparisons showed that teachers earned similar weekly wages, to other bachelor’s degreed workers; but that teacher earnings were lower on average (Podgursky & Tongrut, 2006).

The United States is not alone in offering public education to its citizens. Countries like Singapore, Finland, and South Korea are all developed countries that have public schools as part of their national framework of education. There are differences between the types of college graduates that teach in United States public schools and public schools in Singapore, Finland, and South Korea. Singapore pays college students accepted into education training programs while they train and covers tuition and fees for future teachers. Finland draws applicants into teaching programs from the top 20% of high school graduates. South Korea focuses on elementary education and offers salaries to elementary teachers that are first in the world. Meanwhile, the United States routinely draws teachers from outside the top-third of college graduates (Auguste, et.al, 2010). The authors of the McKinsey report on Improving Teacher Quality argue that to narrow the quality gap between teachers in the US and teachers in Singapore, Finland, and South Korea, teacher salaries in the United States need to be increased to induce more top third college graduates into education.

Recent research on teacher salary is closely connected to teacher quality. The notion of blanket increases in teacher salary are politically and socially unpopular. In general, we accept the idea that a higher quality good should cost more than a lower quality good. We accept this in terms of wages as well – many are willing to pay more for higher quality doctor care than lower quality doctor care. However, when it comes to teaching the one-size fits all salary scheduled negates school district differentiation in pay for teachers of a certain characteristic or quality. Research shows that a pay increase of 45% coupled with the requirement of a cut score on the SAT can increase student performance (Yeh, 2011). Moreover, district to district comparison of teacher salaries show that districts with higher salaries for teachers on average, realize an overall increase in teacher quality (Gilpin, 2014).

Teacher pay systems have evolved since their room and board pay schedules of the 1800s – where a teacher in rural areas would rotate to different family homes to educate children when they were free from the harvest season – when teachers would receive a small stipend in addition to room and board. While this pay system eventually augmented into the step schedule that almost all public K-12 teachers are paid on currently, the single salary schedule is not without its detractors.

Two alternative pay systems to the single salary schedule include the merit-based pay system, with its origins in 1700s Great Britain, and the more modern Knowledge-and-Skill-Based pay system. The merit-based pay system is essentially a reward system that pays individual teachers for certain desirable outcomes. The Knowledge-and-Skill system rewards teachers for engaging in skill building that intends to increase student learning. However, performance pay systems are gaining traction across the United States with various results. The research suggests that states, districts and teachers must be open minded when establishing performance pay systems and utilize pilot programs and trial and error to determine the right performance evaluation criteria (Podgursky & Springer, 2007). Moreover, there is evidence that certain foundations and non-profits may play an important role in the teacher performance pay movement. The current salary schedules in education reward years of service and experience over performance. Unfortunately, teacher effectiveness plateau's somewhere between ten and fifteen years of experience. Thus, paying teachers more money just from having twenty-two years of experience and moving to twenty-three years of experience is an inefficient way of paying for increased student learning. Utilizing foundations, grants, and district monies to incentivize capped performance pay after a certain level of experience may be a more effective way to use teacher salary incentives to increase student performance results (Podgursky & Springer, 2007).

Practical research on student achievement and teacher quality related to opportunity costs involved with making the decision to teach is limited. However, many policy makers make the claim that increasing salary will help improve the quality of teachers in the classroom. They base these claims off of reports by the National Commission on Excellence in Education, the Carnegie Forum on Education and the Economy, and the National Commission on Teaching and America's Future (Goldhaber & Player, 2005). This is consistent with the aforementioned public opinion on teacher salaries – that they are not high enough. There is difficulty in understanding the opportunity cost of teaching in general because each individual teacher's opportunity cost will vary based on their background and past experience. "Opportunity costs – the salaries teachers must forgo to enter and remain in the teaching profession – can differ significantly from individual too individual" (Goldhaber & Player, 2005, p.12). This may be the case because teachers in general earn one salary, based off of experience (Podgursky & Springer, 2006) but teachers are all qualified to teach with two requirements: a bachelor's degree and a teaching certificate. However, the costs of a bachelor's degree and teaching certificate are both sunk costs of teaching and required of all public school teachers – meaning it is not a point of differentiation between types of teachers. What does differentiate teachers from each other are *the other jobs they are qualified to do*. This is how an individual teacher will measure their own opportunity cost. However, for STEM teachers we can safely accept that they are qualified to teach STEM because of their college degree in an area of science, technology, engineering, or mathematics and they are qualified to have a STEM career because of their educational training. So while it is difficult to calculate opportunity costs for teachers as a whole, calculating opportunity costs for specific types of teachers, especially at the secondary level is functionally easier.

Research around the notion of teacher salary for STEM teaching positions shows that increases in teacher salary for STEM teaching positions increases the aptitude of STEM teachers in the field (Gilpin, 2012). Moreover, Gilpin found that increased salary correlates positively with increased aptitude for STEM teachers; however, increasing salary for the bottom 40%, in terms of aptitude, of STEM teachers does not lead to a marked improvement in aptitude scores for those teachers. This research indicates that perhaps if STEM teacher salaries were increased, opportunity costs of teaching STEM would be lowered for higher aptitude STEM *potential* teachers and these individuals would be more likely to enter teaching due to lowered opportunity costs of teaching as a career.

Adding to the understanding of differentiated opportunity costs based on the subject taught, research indicates that elementary teachers, middle school teachers, and special education teachers are paid similarly to other workers with similar qualifications. However, when comparing high school, or secondary, teachers they earn between 7 and 14 % less than demographically similar workers in other occupations (Sojourner, et.al 2014). As teachers increase their specialty of discipline, as required for most high school teachers, their opportunity cost to teach increases with it – as they could be earning higher salaries in other professions.

A recent report by the Learning Policy Institute discussed several aspects of teacher shortages facing the United States. Much of the discussion centered on salaries and other compensation for teachers, most notably the impact salary has on retention and recruitment into education. For example:

> "Studies show that teachers' salaries can affect the supply of teachers both in the short run especially the distribution of teachers across districts and the long run in terms of the quality and quantity of individuals preparing to be teachers. [It is] estimated that an 11% increase in the weekly salary of teachers increases the proportion of college graduates who are willing to work as teachers by 26%." (Podlosky et al., 2016, p. 10)

Clearly salary is demonstrated as a pull incentive into teaching, but only when it lowers the opportunity cost of entering the education in comparison to alternative fields. The choice potential pre-service teachers make prior to entering education can be influenced by increased weekly salaries.

As discussed prior, teacher quality is strongly correlated with student achievement. However, there is growing evidence that teacher aptitude declined substantially over the last 40 years (Leigh, 2010). The question posed in this research is whether or not teacher salaries can be used to improve teacher quality. The answer to that questions is made more difficult to determine because of the following paradox: does salary affect teacher quality, or does teacher quality affect salary? If salary increases do increase quality applicants for teaching positions, shifting the supply schedule of teachers to the right, this increased supply of labor could lead districts to lower wages because of increased competition, therefore an outsider might, “erroneously conclude that higher salaries do not attract better teachers.” (Leigh, 2010, p.2)

In order to determine the impact increased salary would have on teacher applicant quality, this research looked at pre-service teachers, those in college and majoring in education who plan to become teachers when they graduate. The research found that, “a 1% increase in teacher salary is associated with a .6-point rise in the average percentile rank in of potential teachers.” (Leigh, 2010) Ultimately, increasing salary and thus prestige of teaching, will attract higher quality individuals into gaining teaching credentials in college.

When college-bound high school seniors attempt to determine what their major will be and potentially what their career may be, there is a calculus all students do that helps determine their choice. Behavioral economic theory dictates that individuals make decisions with their own best interest in mind and that we calculate our opportunity cost whenever we decide between two choice outcomes. Briefly, opportunity cost measures the value of the not-chosen as the cost of what an individual does choose. For example, it is a Friday night. Your social calendar could include dinner and drinks with friends or curling up on the couch with take-out. While it is true that you could drive across country, bound a flight for Paris, or pen the next great American novel, neither of those options are in your top two choices – in this example your two most preferred options are going out with friends or curling up at home.

Say your choice is to curl up at home. This choice signifies two truths about the decision maker – it was in their best interest to stay at home, as they are free to make decisions to maximize utility and it is expected that is how rational actors will choose.

Second, the utility derived of going out to dinner with friends, or the value, MUST be less than the value of staying home. Therefore, the opportunity cost of staying home is the value lost by not going out with friends. While it is true that the individual preferred to stay home, it is not true that it cost the individual nothing to do so – they still lost out on the benefit of being with friends.

This same logic can be applied to career choices. When applying the opportunity cost principle to an individual that decided to become a high school science teacher, the value of whatever their next best option was must be lower than the value they derive from being a high school science teacher. Keep in mind that research indicates that teachers react no differently than other employees when reacting to salary as a motivator. It may not be true that a high school science teacher is deciding between being a physics teacher or an electrical engineer; but rather, a physics teacher or a retail worker. This could be because they do not have the aptitude or skill to be an engineer, which pays relatively more in salary than a public school teacher in labor markets, and therefore are not really giving up that salary to enter into teaching.

Unfortunately, the reverse may be true as well. Those who determine that being an electrical engineer is the better option than teaching may actually be those with higher aptitude and skills, but determine the value of giving up the electrical engineering job is too steep a price to enter teaching. Thus, the opportunity cost of teaching for these individuals is too great and they do not enter the teacher pipeline.

Walsh investigates this concept and determined that, “moving up one standard deviation in math SAT score increases the opportunity cost of teaching by $2000 after four years and $3800 ten years after college.” (Walsh, 2014) The implications of this research, “policy makers should do so (re-examining the unified pay scale) in a way that increases the rate of increase in teacher pay, as the opportunity cost grows over an individual’s career,” (Walsh, 2014) connects with Hendricks research of increasing novice teacher salaries at a higher rate as a means of retention.

Teacher Attrition, Retention, and Recruitment Efforts

Teacher attrition is can be defined through macro-analysis by reviewing the rate at which teachers leave their current position or on a micro-analysis by reviewing a teacher by teacher rationale as to why they leave. Often a teacher may leave from one school to another, but sometimes they leave the profession all together. Recent research shows the importance of reducing teacher attrition (Hendricks, 2014; Phillips, 2015). Moreover, it is not only in education that reducing attrition or turnover is seen as a net-positive – for-profit firms have understood the importance of reducing attrition for years.

Teacher attrition, retention, and recruitment are all aspects that influence the teacher labor market. The demand, supply, and conditions of work will all effect how long teachers stay in the classroom, who is in the classroom, and who leaves the classroom. Teacher labor markets, like labor markets for other professions, are relatively normal. There is relative ease to enter the market, one needs a bachelor’s degree and a teaching certificate, and over the last 20 years it has become easier to enter the teaching field (Henry, et.al, 2014). However, over the last 20 years, teacher attrition has increased as nearly 8% of all teachers leave the profession every year, more than double Finland and Singapore (Sutcher, et.al, 2016). Teacher attrition is on the rise and this is concerning for two main reasons: (a) it is costly to train new teachers (Henry, et.al, 2014) and (b) teachers are most effective by year five of their career (Loeb, et.al, 2015).

A recent report by the Learning Policy Institute looked into the current teaching labor markets in the United States on a state-by-state basis. The report's findings indicated that over 300,000 teachers will be in demand over the next ten years, with most of those positions due to attrition. Moreover, fewer individuals are seeking teaching as a potential career as entrants into teaching preparation fell by over 35%. In terms of specific subject areas realizing a shortage, two STEM fields made the list in over 40 states: Mathematics (42) and Science (40). The recommendations of the researchers include focusing on lowering the attrition rate through greater support for beginning teachers and increasing the attractiveness of teaching through salary considerations or other financial incentives such as loan forgiveness (Sutcher et al., 2016).

A focus on attrition, or the supply side of the teaching labor market, shows that while 8% of teachers leave the classroom each year nearly a third of new hires into education are actually re-hired teachers (Sutcher, et.al, 2016). A factor on the supply side that could affect attrition rates is what types of individuals are looking for teaching positions in the first place. An analysis conducted by Flyer and Rosen (1997) showed that individuals who did not plan on staying in the labor market long term, perhaps to raise a family, entered teaching because of the ease of entry, steady labor market, and lack of extreme fluctuations as part of the hiring process. Moreover, the reduction of relative teacher salaries to other professions led a decline in female college graduates choosing teaching as a career from 50% in the 1970s to less than 10% by 1990 (Flyer and Rosen, 1997).

As attrition is a real problem facing school districts, the quick solution is one of recruitment. Getting new teachers into classrooms is essential for school districts in order to keep class sizes as small as possible. With the increased importance on recruitment, coupled with the information about teaching candidates declining (Sutcher, et.al, 2016) who exactly is coming to teach? Kihn and Miller (2011) focus on how educators are attempting to attract the best and the brightest. The reality is that over the past 40 years the quality of the teaching force has dropped:

> "Up through the mid-1970s, the academic quality of the teacher corps in the United States was effectively subsidized by discrimination: Talented women and members of minorities became teachers at high rates in large part because they didn't have many opportunities outside the classroom." (Kihn and Miller, 2011, p. 2)

As the glass ceiling shattered for women, and female college graduates realized more opportunities outside of "traditional" female occupations like nursing and teaching, the quality of teachers fell (Bacolod, 2007). This is due in part to gender neutralization in all labor markets. An analysis of high school standardized test scores for college educated women indicated that decline in the relative ability of the average new female teacher. The research also suggested that the quality of the average male teacher increased over the same time frame, but that the share of men in education had not changed enough to increase overall teaching quality (Corcoran, et.al, 2004). These findings are supported by Bacolod, 2007; Correa, 2015; and Auguste, Kihn, and Miller, 2011.

Teacher attrition can be affected by several factors, including salary. Research conducted by Ondrich, Pas and Yinger (2008) reviewed the impact of teacher salary *outside* of education on teacher attrition rates. They found that in school districts with higher salaries in relation with non-teacher salaries, attrition rates are lower:

> "Our results indicate that the level of teaching salaries relative to regional nonteaching salaries for college graduates has a significant impact on the probability that teachers will quit teaching." (Ondrich, et.al, 2008, p. 139)

This research suggests that individuals employed in the teaching field will stay in education so long as it is a relatively well paid profession in comparison with other college graduates within a region. Other research (Imazeki, 2005; Hendricks, 2014; Hendricks, 2015) suggests that increases in teacher pay may induce teachers to stay in the profession, but question whether the benefits of retaining teachers are worth the cost in salary increases to do so.

There is an old adage that when the economy is bad, teacher quality increases. In the field, we discuss this logically in the sense that compared to other industries, education is more insulated than for profit industries when the economy struggles. In general K-12 teaching positions are not subject to outsourcing, and as long as there are students, there are teachers. When coupled with the push toward alternative certification in many states, and the relative ease to be considered a credentialed teacher, a downturn in the economy can quickly affect the quantity of labor supplied in the teaching labor market. An interesting research question that stems from this phenomenon is whether the influx of teaching candidates during a recession improves student learning – or in other words how do alternative job opportunities impact teacher quality?

In an effort to answer that question, researchers used value-added measures to see what impact alternative job opportunities impact teacher quality. "Individuals entering the teaching profession in the United States tend to come from the lower part of the cognitive ability distribution of college graduates." (Nagler, et. al, 2015) When there is a recession, the salaries offered for teaching may be higher to laid-off workers than the alternatives because of the professional requirements of teaching. For example, a laid-off architect, while not able to find employment designing retail centers, may be able to choose between teaching architecture at the local technical high school or working retail in a hardware store. The assumption is that the unemployed architect would choose teaching, and its relatively higher salary compared to hourly retail work, and therefore improve the level of teaching quality in the market.

The research findings determined that during recessions, “that teacher who entered the profession during recessions are significantly more effective than teachers who entered the profession during non-recessionary periods.” (Nagler, et.al, 2015) The implications of this research shed light on two important points. First, evidence may suggest that high quality potential teachers will choose other professions, presumably with higher levels of prestige or remuneration, during non-recessionary points in the business cycle. The second point is when high quality individuals join the teaching field during recessionary periods, how do school retain them during periods of non-recession.

Opportunity Cost of Teaching

Opportunity cost, defined as the, “value of what you must give up when you make a particular choice,” (Ray & Anderson, 2011, p. 4) is a cornerstone of economic theory and analysis. Whenever an individual must make a choice, the concept of opportunity cost is put to use. Often we think about choice as selecting an option we like *best* out of all of our options, but the concept of opportunity cost is not necessarily about the best out of all the options, but rather an analysis of what you lose when you make a choice. A rational actor will make the choice that has the lowest value of what is *not chosen.* For example, if I go car shopping, the car I like best may be a BMX X5M, retail price $108,000 (BMW, 2017). While I may to technically be able to afford this car and therefore factor into the demand equation for this vehicle, I will have to forgo certain other aspects of my life to purchase this vehicle. The concept of opportunity cost tells me that this car is *not* my best option because the value of what I give up to purchase this car is greater than the utility I may derive from it.

This concept of opportunity cost can be applied to any choice an economic actor makes, where the focus of the decision is on what is given up rather than what is gained. When considering career choices, the simplest way to understand opportunity cost is to look at salary. When someone who is qualified to be both an electrical engineer and a physics teacher choosing one career over the other will create a loss of salary equal to the salary of the career not chosen. When considering teaching positions to non-teaching positions, the salary of a teacher versus the salary of a non-teacher will help determine a simple opportunity cost of either teaching, the forgone non-teaching salary, or not teaching, the forgone teaching salary. The expectation is that individuals in the labor market are rational and will make decisions based on limiting their opportunity costs.

Murname and Olsen (1989) investigated the influences of salaries and opportunity costs of teaching as a career in North Carolina. They reviewed predictors of leaving teaching including gender, exam scores, subject area, and secondary or elementary level of teaching to determine what impacts each area would have on a teacher's likeliness to leave teaching. They also determined that higher teacher salaries, especially at the beginning of a career, increase longevity. They determined, as did Kershaw and McKean (1962) that Chemistry and Physics teachers (STEM) have the shortest tenure in the classroom, an average of 4.6 years, due to the high opportunity cost of teaching for these individuals. Moreover, they determined that elementary teachers face lower opportunity costs of teaching and stay in the classroom longer than secondary teachers. It was also determined that teachers who score higher on the National Teacher Exam (NTE) are in the classroom for less time on average than those who score lower on the exam (Murname & Olsen, 1989).

While Murname extensively studied the opportunity cost of teaching, until recently there was limited research into the question of the opportunity costs of teaching. However, in recent years Goldhaber, et.al, 2008; Gilpin, 2011; West, 2013; and Rickman, et.al, 2016, investigated teacher opportunity costs.

Goldhaber et.al (2008) studies the impacts of the teacher salary schedule and its impact on the opportunity costs of teaching. The vast majority of school districts in the United States use a graduated salary schedule for *all* teachers that increase the level of pay for a teacher based on years of experience in education. This salary schedule is built to retain teachers over the long run of their career, often maxing out after 20 years of educational experience. There is evidence that school districts have attempted to minimize opportunity costs for new college graduates by increasing starting teacher salaries. However, over time the salary gaps between teachers and non-teachers with similar qualifications become larger, increasing the opportunity cost of teaching past the first few years in a classroom. This gap is larger for specific types of teachers, namely math and science teachers (Goldhaber, et.al, 2008).

Gilpin (2011) reviewed salary schedules and their impact on attracting and retaining teachers. His study reviewed the extent to which wage differentials affect teacher attrition through the utilization of a utility model. The results indicated that for teachers who leave the profession for employment in a non-teaching full time job earn more than they do as teachers. Moreover, within the first six years of teaching wage gaps between teaching and non-teaching careers are more impactful. A 1 percentage point wage differential between teaching and non-teaching position leads to a 3.1 percentage point increase in likeliness to leave teaching. Research by Hendricks (2015) supported the notion that within the first years of teaching that wage differentials impact teacher attrition at a higher level than later in teaching, in other words, paying teachers for longevity is not beneficial to keep those who can gain employment in another field from leaving early on in their career.

A report by West (2013) reviewed whether mathematics and science teachers earn more outside of the classroom than staying inside the classroom. He reviewed student scores on the ACT which showed that only 46 percent of testers met college-readiness benchmarks in math and that one in three testers met the college-readiness standard for science. The implication is that the quality of teachers in math and science classrooms is not strong enough to lead to college-ready understanding of math and science principles.

“Improving the caliber of our math and science teachers is essential to changing this picture. A large body of evidence confirms that teacher effectiveness is a key determinant of students’ academic progress. The quality of math and science teachers is the most important single factor influencing whether students will succeed or fail in science, technology, engineering and math.” (West, 2013, p.1)

West argues that a method of improving teacher quality in math and science classrooms is to pay math and science teachers higher salaries to reduce the opportunity cost of teaching in a STEM classroom. He concedes that other factors influence individuals to teach besides income, but that, "ample evidence confirms that salary levels strongly influence teachers' career paths." (West, 2013, p.5)

One solution to increase the quality of math and science teachers in public school classrooms is to create a salary schedule that pays teachers based on the demand of their certification. However, recent surveys concluded that only 33 percent of respondents supported paying teachers for working in shortage areas such as math and science, and over 59 percent of teachers disagreed with differentiated pay based on demand. Much of this concern rests on the notion that educators who do not teach math and science are less valuable than those who do teach a STEM course. However, the reality is that by not allowing differentiated compensation that STEM teachers are, "being asked to make a larger financial sacrifice to enter and remain in the profession." (West, 2013, p.8)

Rickman, Wang, and Winters (2016) expanded on opportunity cost research through the utilization of American Community Survey (ACS) data at the state level. ACS collects responses about work and community information. This study reviewed information about teacher salaries and college graduate non-teacher salaries on a federal tax-adjusted basis. The findings indicate that higher relative salaries to other college graduates within a region help retain higher quality teachers to the profession. Essentially, by lowering the opportunity cost to teach in a given area, the likelihood of keeping good teachers increases. These findings were strongest for males certified to teach Science, Technology, Engineering, and Mathematics across survey respondents for 2009-2011 (Rickman, et.al, 2016).

High opportunity costs of teaching may drive talented teachers away from the field and into higher paying jobs for which they qualify (Murname, 1989; Goldhaber, 2008). One method of counteracting high opportunity costs is to implement wage-differentials for teachers based on certification and courses taught (Mason, et.al, 2015). The teaching labor market is similar to other labor markets in that salary is a large factor in worker participation in the market. Where teaching markets are dissimilar from other labor markets is that in general, teaching markets do not pay wages based on performance and quality, but uniformly on years of experience. This notion is based on the idea that all teachers teach students, but all professional hockey players play hockey, but better performers are paid better wages. The researchers find that differential wages will help draw quality teachers into the labor market to improve student learning, by lowering the opportunity cost of teaching STEM:

> "With more math oriented individuals who are drawn to teaching because of their aptitude for instruction in school classrooms, more students will likely be enlightened to the joys of learning math, leading to more math teachers in subsequent generations at all levels – including the primary level where the present hatred and ill preparation begins." (Mason, et.al, 2015, p. 112)

The solutions to lowering the opportunity cost of teaching are important to determine efficiently. Wage differentials can reduce the opportunity cost of teaching, especially for STEM teachers, and bring higher quality educators into the classroom (Mason, et.al, 2015).

To understand teacher career options requires an analysis of the opportunity cost teachers face when remaining in their current positions. This analysis is important to review as, “each year taxpayers are paying at least four billion dollars to replace teachers,” in the United States (Feng, 2009).

The analysis reviews several factors that impact the cost of remaining in a current position relative to leaving for another position. One factor is weighing the option of increasing one’s salary by leaving their current profession –as lower current salary increases the likeliness of leaving education. Another factor is classroom characteristics, as more challenging students make it more likely a teacher will leave at the end of a school year. While we may think of behavior when considering a challenging student, it is also important to note that with shifting importance placed on student performance as a measure of teacher and student quality, teachers may leave a position teaching academically lower students toward teaching more academically successful students. School working conditions including safety, demographics of student bodies, and physical location of the school, along with salary increases by switching teaching positions, and cost of living analysis within different locations.

The research suggested that once teachers enter the teaching work-force that their retention is relatively inelastic to wage increases. Therefore, raising current teaching wages may not have an impact on keeping teachers from moving to other industry in search for higher salary. However, working conditions of the school are an important pull factor that will move teachers in and out of their current positions. Hard-to-staff schools would have to pay a $10,000 per year premium to retain teachers, or they could find, “ways to improve the school environment by reducing disciplinary problems or redistributing unruly students to veteran teachers.” (Feng, 2009)

STEM Teaching

Secondary school teaching requires two aspects of preparation for the teacher to be adequately equipped for success in the classroom: first, excellent pedagogy, and second, excellent content knowledge. Previously discussed literature reviewed the gaps in opportunity cost for individuals with a bachelor degree in a STEM field from entering education. These same gaps do not exist at all, or are at least more narrow, for individuals with a bachelor's degree in History or Literature, other commonly taught core subject areas in addition to the STEM fields of Science and Mathematics (BLS, 2017).

Because the opportunity cost for STEM teachers is different than that of other core education fields, reviewing literature specifically about STEM teachers is important. This section will touch on preparation and induction of STEM teachers, retention, attrition, and recruitment of STEM teachers, and reasons for STEM teacher turnover.

STEM Teacher Preparation, Induction, and Professional Development

Research by Wilson (2011) reviewed different programs and aspects of effective STEM teacher preparation. STEM secondary teachers in the United States are proficient at mathematics, in comparison to the rest of the world, showing strengths in calculus, geometry and functions. Where pre-service STEM teachers need to improve are in areas of pedagogy (Wilson, 2011). Pedagogy is the study of learning – essentially the methods and means of student education. Research shows that more effective teacher preparation programs have the following features: (a) produce a required capstone project; (b) careful oversight of the student-teaching experience; (c) a focus on practical coursework; and (d) opportunity for professional development within a school district's framework (NAE, 2010).

However, because of the shortages in many school districts in the United States, there is a plethora of *alternative* teacher preparation programs that may not offer the same breadth of practical or pedagogical refinement as a university-major based program (Wilson, 2011). To combat the competition from non-university based alternative programs, researchers have developed criteria for developing best practices for STEM teacher preparation. These criteria include the following: (a) methods taught should correlate with methods that will be used when teaching in the classroom; (b) methods should help to improve learning for all students; (c) methods should support student work that confirms the content area; (d) methods should be conceptually accessible and appropriate; (e) can be revisited with greater depth and complexity over time; and (f) should align with the overall system of instruction within the school system (Ball and Forzani, 2009; Wilson, 2011).

Beyond STEM teacher preparation, which research shows should focus on pedagogy rather than content knowledge alone, new teacher induction is an important aspect of STEM teacher preparation and development. Induction usually involves the actions of peer-mentoring, teacher evaluation, teacher on-the-job training, systems training, scope and sequence training, classroom management training, and other district and school required professional development. The value of an effective induction program usually leads to better retention and more effective teaching. For example:

> "Novice teachers who participated in induction programs that involved working with a mentor from their same field, collaborating with same-subject teachers, and participating in other teacher networks were more likely to stay in the profession and less likely to leave their current position." (Wilson, 2011, p.7)

Furthermore, another study showed evidence that subject-specific induction programs leads new teachers spending more time teaching STEM courses and less time focusing on the other aspects of teaching such as classroom management issues (Mikeska, et.al, 2011).

The three aspects of teacher preparation include: (1) the initial training conducted in a university or alternative setting; (2) the induction process for teachers new to the industry; and (3) ongoing professional development. Professional development is offered in a variety of methods from online webinars, campus or peer group book studies, face-to-face lectures, consultants, and a variety of other methods. Many studies suggest that effective professional development, "focuses on subject matter, draws upon teachers' current practices and experiences, and is intensive and sustained," (Wilson, 2011, p.11).

Professional development is intended to help teachers effectively teach their subject matter. Therefore, professional development generally focuses either on subject area content or effective teaching practices. For STEM teachers, content focused professional development has a modest positive effect on improving opportunities for active student learning. Moreover, professional development that focused on pedagogical knowledge and skills were associated with positive changes in instructional practice (Garrett, et.al, 2001).

STEM Teacher Retention and Turnover

Teacher turnover costs the United States public school system roughly 2.2 billion dollars annually according to a recent study (Ingersoll, 2015). Whether new teachers are leaving, or veteran teachers are retiring, that figure is staggeringly large. The migration out of the profession leads to the hiring and training of new teachers nearly every year, and this process seems to repeat itself annually. Much of the attempt to “fix” this problem has been on the recruiting side of the equation, in other words if there are job openings, schools and districts have worked at finding people to fill the positions. Recently some of the research has shifted to the retention side to try and determine what could be done to keep the teachers before they leave in the first place.

Ingersoll and May (2012) investigated teacher retention and turnover, specifically with regard to STEM teachers. Their study investigated mathematics and science teacher mobility, mathematics and science teacher destination, and teacher rationale for movement. The researchers found that regional differences in non-teaching labor market wage differentials could lead to STEM teacher to leave the classroom for higher wages (Ingersoll and May, 2012). Moreover, the rate of Math and Science teachers is not much different than other types of teachers, indicating that perhaps:

> “[M]ath and science majors who decided to go into teaching may have lower academic ability than their fellow majors who pursued careers in industry and hence do not feel they realistically have similar career options.” (Ingersoll and May, 2012, p. 456)

Career Choice

Employment offers individuals the resources to fund their basic needs of food, shelter, and clothing (Blustein, 2006). Once basic needs are met, individuals can then focus on other aspects of employment that match their preferences. Research supports the notions of employment choice focusing on the following criteria: Social Connection and interpersonal relationships (Bowlby, 1982; Jordan, et.al, 1991, Blustein, 2006); construction of self-identity (Schein, 1990); psychological well-being (Quick and Tetrick, 2011); self-determination and the development of intrinsic motivation (Ryan and Deci, 2017); and skill building and human capital development (Blustein, 2008). While this study is primarily focused on the teacher labor market and the opportunity cost faced by individuals deciding to enter the teaching market, it is important to understand that literature supports the notion that employment choice is a factor in many labor markets, not just teaching labor markets.

Prior to determining how individuals decide whether or not to enter the teacher labor market it is important to understand how individuals decide on college majors, which generally lead to career choices. First, there are clear links between higher education choices and labor market outcomes, as exemplary work aligns with the benefits of college education for job attainment and earning (Binder, et. al, 2016). This study attempts to define how college students decide on career paths.

The qualitative study involved interviewing 56 interviews of college students, 27 at Harvard and 29 at Stanford. Of those interviewed, nearly 40 had not graduated with a four-year degree and the rest were graduate students. The findings indicated that student career decisions were not based solely on individual preferences but on organizational influence in addition to personal preference. Moreover, students at highly selective institutions, such as Harvard and Stanford, students “must actively construct the meaning of certain jobs as prestigious before they can pursue them in such large numbers” (Binder, et. al, 2016). In short, colleges and universities play a large factor in influencing undergraduates toward certain majors and career fields. Considering the impact high quality, high intelligence teachers have on students, this study supports the notion of pushing elite universities toward teacher preparation and recruitment.

Teacher Career Choice

Currently there are over fifty million students in public K-12 schools in the United States. The growing demand for teachers of high quality has led to many states to open up alternative certification paths to teaching, emergency contracts, and waivers to hire teachers without the right certifications. With it becoming much easier to earn a teaching certificate without going the traditional route, why do individuals still go the "traditional" route to gaining a teaching certificate, which includes: enrolling in a four-year college preparatory program, majoring in education, graduate with a diploma and a certificate, in four years, and begin teaching in public school the first year after graduation?

To determine what motivates individuals to become teachers in the traditional way, researchers conducted a mixed-method study that included interviews and a survey to individuals currently enrolled as education majors at a four-year university in North Carolina. The researchers were specifically attempting to determine what individual responses were for the motivations to become teachers and if they could cluster any of the results to create a typology of what a pre-service teacher was motivated by in general.

Three distinct clusters of pre-service teachers were identified enthusiastic, conventional, and pragmatic (Thomson, et. al, 2011). The enthusiastic cluster included high ratings for building meaningful relationships, family members or former teachers influenced their desire to be a teacher, and altruistic reasons for teaching. The conventional cluster shared high ratings with the enthusiastic cluster for altruistic reasons for entering the teaching field, but differed in the importance of personal relationships being a lower motivational factor and their own abilities as higher rated motivational factors. The third group, the pragmatists, identified job benefits as a major motivator to entering the teaching field, and valued relationships less importantly than the other clusters (Thomson, et. al, 2011).

Similar to the Thomson study, Watt and Richardson conducted a typological cluster study on student motivations to enter the teaching field. The used a different instrument in their survey, the FIT-Choice scale as opposed the Reason for Teaching Scale (RTS) used by Thomson. The method used was a survey and no follow up interviews were conducted. In all, 510 respondents, across three Universities in Australia, were surveyed. All participants were graduating teachers from the university program that they attended.

The three clusters uncovered by this survey included the following: highly engaged persisters, highly engaged switchers, and lower engaged desisters. The FIT-Choice scale measured responses within four broad categories: planned effort, planned persistence, professional development aspirations, and leadership aspirations. The highly engaged persisters, much like the enthusiastic cluster in the Thomson study, scored highest in all four categories. They planned to teach for their whole career, had a passion for teaching that motivated them to the profession, and were highly motivated by intrinsic reasons. The highly engaged switchers were motivated to enter teaching for many of the same reasons as the first cluster, however, their long-term plans did not include teaching for their entire career. Interestingly, many of the individuals that fell into this category were planning on being art teachers and thought of teaching as a way to support themselves in the beginning stages of their art careers, “I enjoy teaching, and cannot yet survive as an artist.” (Watt and Richardson, 2008) The final group, the lower engaged desisters, were disaffected with their choice to become teachers. Teaching is too much work, too much work preparation, and too little support (Watt and Richardson, 2008).

The differences in motivation between Thomson's clusters and Watt's clusters can be explained by the use of different survey instruments and methods of collecting information. However, it is notable that both research teams found about 44% of their respondents (93/210 for Thomson, 225/510 for Watt) were highly enthusiastic, intrinsically motivated, and career focused educators. However, as noted previously there is a dearth of high quality teachers being produced for the current market. If only 44% of university students that are graduating with teaching credentials are excited to enter the teaching workforce, without any measure of the quality of that 44%, the gap may in fact widen with who is choosing teaching as a career and their relative quality as an educator.

Previously discussed literature by Watt and Richardson (2008) and Thomson (2011) discussed why certain individuals went into teaching. While their input is useful in determining why they chose to go into education, it does not help answer the question about why certain people *do not* enter the teacher labor market. "If we are to get a clearer understanding of what attracts certain people into teaching, we also need to explore how teaching is viewed by those who choose other careers." (Kyriacou and Coulthard, 2000, p. 4)

The researchers surveyed 466 college students that met the following criteria: current undergraduates at the time of the survey, two-thirds were education majors and one-third was not. A survey of those that did not respond to the original survey found no major differences in education, demographics, or other notable characteristics. The results indicated that those who are strongly considering a teaching career view the perception of a teaching career positively. However, this study suggests that measures taken to improve teacher recruitment need to focus more attention on those factors that undergraduates who are undecided about teaching as a career view as important in influencing their choice of career (Kyriacou and Coulthard, 2000).

While it is important to understand what motivates pre-service teachers toward a career in education, understanding what keeps teacher in their jobs is a different question, but equally important to understand when trying to improve teacher quality. As discussed previously, teacher quality is an important factor in maximizing student learning outcomes. Also as previously mentioned, teacher tenure and salary schedules make recruiting new teachers, regardless of level of quality, difficult for human resource managers and school principals.

This mixed-method study used an anonymous survey of 169 experienced teachers in a California suburban school district with 67.8% Caucasian students, 10.7% Asian, 15.6% Hispanic, and 4.7% African American. The district is economically middle class, with a large range of incomes. 426 surveys were distributed to teachers, with 169 returning surveys (40% response rate). The survey measured the following areas: overall job satisfaction, motives for remaining in the classroom, and beliefs about teaching and personal efficacy. All survey questions were on a 4-point Likert scale and 60% of teachers that submitted the survey agreed to a follow up interview with the research team. The interview questions attempted to elicit more specific responses and reflections on what motivated teachers to remain in the classroom.

The results indicated that teacher’s main motivation for staying in the classroom was working with students and seeing them grow, having a passion for the subject area the teacher instructs, the emotional and intellectual excitement of the classroom, the autonomy of teaching high school, the collegiality of working with other teachers closely, importance to society. The least important motivators for teachers were those of a practical nature: salary and benefits (Brunetti, 2000).

While this survey included a small sample size (169) from a middle-class suburban school district, the understanding of what keeps an experienced teacher in the classroom is helpful in determining how to retain teachers – by focusing on the societal and personal rewards of teaching rather than financial benefits.

Once an individual decides to take a path toward an education career, it may be useful to understand their perspectives on teaching as those perspectives can be windows into the internal motivation and thought process used to make their career path decision. Keeping in mind that, research on pre-service teachers' perceptions suggest that teacher education courses do little to alter the perceptions students develop when they themselves are in school as students (Fajet, et.al, 2005). This research included an online survey and interview of students enrolled in an introductory education course at a southeast United States university. This mixed-method study attempted to determine what the perception of good teaching is from neophyte pre-service teachers.

The findings of the study indicate that classroom management, pedagogy, and affective personal characteristics are the broad categorical expressions of importance to newly enrolled pre-service teachers. Within the categories of classroom management and pedagogy the following characteristics were determined to describe good teachers: creative, make learning enjoyable, fun and interesting, make learning relevant, and differentiation of instruction. The important characteristics within the category of affective personal characteristics included: enthusiastic, energetic, passionate, motivating, caring, patient, engaging, fair, open-minded, and nice (Fajet, et.al, 2005).

The concerns in the outcome of this research indicate that of the characteristics that indicate what determines a good teacher most of the characteristics can be described as personality traits. The evidence does not suggest that teachers need to be intelligent, highly skilled in their disciplines, or thoughtful problem solvers. When considering the notion that pre-service teachers' views of teaching remain mostly unchanged from their college level education courses – a clear concern emerges. Pre-service teachers entering preparatory programs are expecting their personal qualities to be more important than their pedagogical qualities. However, with the weight that a high quality teacher plays in the equation of student learning – this preconception can potentially have a major impact on who ends up entering classrooms.

Watt and Richardson (2008) developed a model for determining pre-service teachers' motivations to enter the profession called the FIT-Choice Model. They used the FIT-Choice model to review motivations for pre-service Australian future teachers. Lin extended the same analysis, using the FIT-Choice model, to compare the motivations between United States and Chinese pre-service teachers (Lin, et.al, 2012). The rationale for this comparison includes the opportunity to understand the unique challenges the United States and China face in recruiting and training teachers – essentially the sheer numbers of teachers needed to adequately staff schools. The United States has over 50 million K-12 public school students, China has over 200 million K-12 students. For each country, understanding what motivates their teachers to teach is not merely an interesting academic foray – it is knowledge that can aid policy implementation.

Both countries rated shaping the future of children, making positive social contributions, prior personal experiences with teachers, and enhancing social equity as strong motivators for entering the teaching field. United States teachers view teaching as having strong job transferability – allowing them to work in a variety of locations in the world – as compared with Chinese pre-service teachers. United States preservice teachers were more likely to be attracted to teaching for altruistic reasons, even though they were motivating factors for both countries' preservice teachers. Meanwhile, Chinese pre-service teachers viewed teaching more as a fallback career than did their United States counterparts. The results also indicated that more Chinese pre-service teachers enter with more reluctance and because of their low university entrance examination scores (Lin, et.al, 2012).

Chapter 3

RESEARCH METHODS AND PROCEDURES

Research Design

Sources of Data

In order to determine the opportunity costs for those who chose STEM teaching careers, compared to those who chose STEM non-teaching careers, four sources of data will be utilized: (a) salary estimates from the Occupational Outlook Handbook published by the Bureau of Labor Statistics(BLS), (b) salary estimates from the National Center for Education Statistics (NCES), (c) the Salary Survey Project published by the National Association of Colleges and Employers (NACE), and (d) responses from semi-structured interviews with current STEM credentialed high school STEM teachers.

BLS data will be used for years 2009-2016, NCES data will be utilized for the years 2009-2015. NACE data will be utilized for the year 2016. Interview data will be used to improve the understanding around individual's rationale for pursuit of teaching by STEM credentialed degree holders. Other data sources were under consideration for utilization, but were not chosen, include: (a) the American Federation of Teachers survey and analysis of teachers' salary trends, and (b) data housed by the National Education Association in the Collective Bargaining Database. The American Federation of Teachers survey data was not chosen because the survey has not been utilized since 2007 making collected data ineffective for a longitudinal analysis. The National Education Association only has starting teacher salaries up until 2012-2013, limiting the effectiveness of a longitudinal survey. Moreover, the United States went through a recession starting in

2007 and full recovery was not realized until 2010 (Rampel, 2010) making salary data for 2007 and 2012 for teachers somewhat of an aberration.

Bureau of Labor Statistics

Salary data from the Occupational Outlook Handbook is collected through multiple surveys by the BLS. Data sets are readily available and can be custom created through the BLS website; however, custom data sets include data from the BLS and not outside data. The handbook includes thousands of jobs, in multiple job categories, with various required levels of education for each job. Moreover, the salary reports are a summative collective of salary at each career stage, presented as a median salary for the occupation.

Salary estimates from the BLS are derived through two sources: (a) the Occupational Employment Statistics (OES) program, and (b) the Current Employment Statistics (CES) program. The OES collects wage and salary data for nearly 1100 occupations by utilizing a semi-annual mail survey of over 1.2 million non-farm organizations. The survey is conducted with support from state work force agencies and the BLS. The BLS creates the survey and selects the sample and provides support during the conduction of the survey. Employers and organizations that agree to respond to the state work force agencies are selected to participate in the survey (BLS, 2017). The CES is a survey program, conducted on a monthly basis and representing over 630,000 unique employment centers including government agencies, private businesses, and other organizations, that provides data on employment, earnings, and hours worked (BLS, 2017).

National Center for Education Statistics

Data were compiled from the NCES reports on median earning for college bachelor degree holders aged 25-29. The data was compiled through surveys by the United States Department of Commerce and the Public Use Microdata Sample (PUMS) data (NCES, 2017). This data is unique from the BLS data as it represents median salaries of recent college graduates, rather than workers with varying levels of experience in a field. This data will closely represent actual starting salaries. The NCES data used in this study are from the years 2009-2015.

National Association of Colleges and Employers

Data were compiled from the NACE report for April 2016. The NACE survey is a quarterly survey of starting salaries for specific careers and the level of education those careers require. The NACE data are unique from BLS and NCES data because NACE data track *starting* salaries for careers, whereas BLS data do not differentiate salary level and experience level, instead presenting salary data as a median for the career and occupation. The NACE data used in this study is for the year 2016.

Occupational selection from the BLS Occupational Outlook Handbook were chosen by aligning NACE college majors and NCES bachelor degrees, to the job descriptions presented in the Occupational Outlook Handbook with educational requirements for the occupation or specific position. The BLS Occupational Outlook Handbook reports occupation information on 819 occupations, covering 83% of all occupation types in the United States economy (BLS, 2017) but not all occupations require the same skill and education requirements as STEM teachers and non-teaching STEM positions. For example, a researcher at the University level generally requires a master's degree in the field of research. However, a master's degree is not universally required to be a secondary school teacher, thus the occupation of *researcher* would not be included in the study comparison.

Semi-Structured Interviews

Data compiled from these interviews will include input from current STEM instructors in a large school district north of Houston, TX. The interviews will be conducted one-on-one and will follow a semi-structured interview protocol. "The semi-structured interview contains a mix of more and less structured questions…the largest part of the interview is guided by a list of questions to be explored" (Merriam, et.al, 2002, p.13). The purpose of using a semi-structured format is that this format allows for more openness and individual response from interviewees when trying to determine their opportunity cost of teaching.

Data Collection

This section explains the data collection process of starting salaries for bachelor's degree holders in STEM education and non-teaching STEM professions, and median salaries for STEM education and non-teaching STEM professionals. This section also explains the interview process conducted with current STEM instructors.

Starting Salaries

Starting salaries for STEM teachers will be procured from the NACE education major tables reporting salaries from 2009 to 2017. It is important to note that teacher salaries in the NACE data are not reported by teaching discipline, but rather by teaching level, for example: Secondary, Elementary, Pre-School. Therefore, STEM teacher salaries are not differentiated from, say, English teachers, Physical Education teachers, or

Social Studies teachers. However, most teachers are paid on a salary schedule based on experience, not teaching discipline. Therefore, for this study STEM teachers' starting salary is considered to fall under the NACE category for Secondary Teacher.

The data utilized to select starting salaries for STEM occupations came from the list of Science(S), Technology(T), Engineering(E), and Mathematics(M) majors in the NCES reports from 2009-2015 and NACE reports for 2016. Specific majors that were considered for inclusion in a STEM major from the NCES and NACE data include the following: Accounting (M), Computer Science (T), Information Sciences and Systems (T), Software Applications (T), Biomedical Engineering (E), Chemical Engineering (E), Civil Engineering (E), Computer Engineering (T), Electrical Engineering (E), Environmental Engineering (E), Materials Engineering (E), Mechanical Engineering (E), Nuclear Engineering (E), Petroleum Engineering (E), Software Engineering (T), Mathematics (M), Biology (S), Chemistry (S), Environmental Science (S), Geology (S), and Physics (S) (NACE Salary Survey, 2017 & NCES, 2017). The final selections of NCES and NACE majors chosen for the data set are listed in Table 4.

The salary data examined for the purpose of this study required the use of salary aggregations collected at the secondary teacher level of specialty to represent those who teach STEM disciplines. Therefore, initial salaries of recent college graduates with degrees in secondary education were compared with initial salaries of recent college graduates with degrees in STEM majors.

NACE reports represent starting salary offers from several perspectives. The report is segmented by curriculum for all types of employers, by functional area for all types of employers, starting salary offers to all candidates by curriculum and employer, and starting salary offers to all candidates by curriculum and job function (NACE, 2017). It is important to note that BLS data does not take into account survey respondent's education level, but rather reports required education for specific occupations. Individual respondents may be more educated than the minimum requirement for that occupation and all salary data is reported as a career median salary. Alternatively, NACE data expresses starting salary offers at each education level, so a bachelor's degree *starting salary* can be expressed an isolated.

Moreover, NCES data compiles salary data based on bachelor degree held for individuals aged 25-29. It is important to note that this age group of workers tends to be individuals within their first job from college and effectively represents a starting median wage in a specific field. NCES data is different than BLS data, where BLS data would represent salaries at all stages of experience, and all levels of education.

Median Salaries

On an annual basis, the BLS publishes average annual and median salaries for 819 occupations in the Occupational Outlook Handbook (BLS, 2017), accessible through their website. The BLS does not report starting salaries for occupations, as does the NACE report. The BLS median salary data is useful in the analysis of determining salaries over the life of a career in a given occupation. In other words, if a recent college graduate wanted to know about what to expect their first year out of college in a given industry, the NACE data would be a more closely aligned value; however, for the *average* or *median* salary an individual could expect for a career, the BLS data is more aligned with those values.

The collection of median salaries for STEM teachers and non-teaching STEM professionals, will utilize BLS data. This data will encompass all years of experience and education within a given field. While NACE data was broken down by college major, making STEM majors explicit in their starting salaries, BLS data only expresses the level of education, not the specific major or concentration of a degree. Therefore, a qualitative process was used to select the most appropriate matches to the starting salary offers for STEM majors and secondary education majors as reported by NACE. The screening process included the following steps: (a) reading the qualifications for the position to ensure a bachelor's degree was required, (b) and the job description must be representative of a job that a graduating major reported in the NACE data would likely enter.

Adjustments to Data

Both median and starting salary data for secondary teachers need to be adjusted because of the work schedule for most secondary school teachers. According to the BLS Occupational Outlook Handbook's description of secondary teachers, "Many work the traditional 10-month school year and have a 2-month break during the summer. Although most do not teach during the summer, some may teach in summer programs." (BLS, 2017, p.1) Therefore, adjustments will be made to non-teaching STEM careers in order to compare salaries on a 10-month work schedule.

The BLS collects median salary information through the compilation of weekly estimated from field economists who survey workers in all occupations. Non-teaching STEM professionals typically receive two-weeks of vacation per year, salaries are annualized on a 50-work week year. This annual median salary will be divided by 12 to determine a monthly average salary. That figure will then be multiplied by 10 to equate to a ten-month salary, in order to compare non-teaching salaries with teaching salaries effectively.

Interview Responses

Interviews will be conducted in a one-on-one setting following a semi-structured interview protocol. A semi-structured interview is defined as an open interview with pre-determined themes, but allows for the interviewer and interviewee to engage in conversation and questions that relate to the responses given by the interviewee (Edwards, 2013). Interviews will be transcribed and reviewed for themes. The purpose of the interview is to determine why current public school STEM teachers stay in the teaching field and do not pursue careers in a higher paying sector. This will help determine some of the potential individual reasons for becoming a teacher and forgoing higher wages in other industries. The interview questions include the following:

1. How did you first become interested in becoming a teacher? What was your experience in choosing teaching as a career?

2. What has kept you in the classroom as a science teacher? Why do you continue to work in this profession?

3. Have you ever considered leaving the classroom during your years as a teacher? What were those thoughts and what happened to eventually make you change your mind and stay in the classroom?

4. Did you have any role models or mentors that influenced your becoming a teacher or the way you work as a teacher? What can you say about their impact on your career?

5. How important is the subject you teach to you being a teacher? Is it your passion for science that motivates you to teach or your passion for working with young people that motivates you?

6. What have been your most rewarding experiences as a teacher? And conversely, what experiences have been the most depressing or discouraging?

7. Are there any other comments or observations you would like to make about your work as a science teacher?

The selection process for interviewees included sending an email to ten teachers in a suburban district north of Houston, TX. The interview asked individuals to participate in a semi-structured interview about teaching in the field of Science, Technology, Engineering, and Mathematics. Of the twenty teachers who received an email, 6 replied that they would be willing to participate in the interview process. Interviews will be conducted in a place of their choosing and a time that is mutually determined. All of the above questions were given as part of the initial email requesting interviews.

Procedures

This study is a mixed-method study. Two forms of data collection will be utilized in this research. This section defines the approaches applied to the data collected through the archival research method. The archival research methodology focuses on (a) an examination of primary documents, and (b) ex post facto examination of recorded information (Pearce-Moses, 2005). By sourcing data through existing databases housed by the BLS handbooks and NACE reports, the archival method allows for the examination of primary source and scientifically collected data. This data will aid in answering the research questions proposed in this study.

Research question one focuses on whether there is a difference between STEM teaching salaries and STEM non-teaching salaries. To determine differences between STEM teaching and non-teaching STEM salaries, I will review annual starting salaries for STEM teachers and STEM professions that require a bachelor's degree. To determine accurate differences, annual salaries for non-teachers will be adjusted to 10-month salaries rather than annual 12-month salaries. Starting salary data from 2009 to 2015 will be utilized for this analysis from NCES reports. Data for starting salaries for 2016 will be gathered from NACE reports.

Research question two focuses on the opportunity cost of choosing a teaching career over a non-teaching career for STEM professionals. This will be measured by analyzing starting salaries through NACE data and median salaries through BLS data for both STEM teaching and STEM non-teaching careers for the years 2009 to 2017. Opportunity cost is a simple equation as it is determined through finding the difference between what is given up when a choice is made. For example, if you have an hour of free time and you could exercise or watch television, the opportunity cost of exercising is not watching television.

To measure opportunity cost for this study I will look at the differences in salary at both the starting level and median level for STEM teaching and STEM non-teaching careers. The starting salaries and median salaries for each studied profession from 2009 to 2017 will be individually analyzed to determine the opportunity cost of making one career choice over the other. Moreover, individual responses to questions about why STEM credentialed individuals teach will expose some of the rationale to choose teaching over other industry.

Table 4

Final Selection of Employment Categories for NCES/NACE Inclusion and BLS Occupational Category

NACE/NCES Category	BLS Occupational Job Title
Science	Science
Biologist	Biologist – 19-1029
Environmental Scientist	Environmental Scientist – 19-2040
Physical Scientist	Physical Scientist – 19-2099
Technology	Technology
Computer and Information Systems	Computer Occupations – 15-0000
Engineering	Engineering
Chemical Engineering	Chemical Engineer – 17-2041
Civil Engineering	Civil Engineer – 17-2051
Computer Engineering	Computer Engineer – 17-2061
Electrical Engineering	Electrical Engineer – 17-2071
Mechanical Engineering	Mechanical Engineer – 17-2141
Mathematics	Mathematics
Mathematician	Mathematician – 15-2021
Accountant	Accountant – 13-2011
Education	Education
Secondary Education, Exclusive of Special Education and Career/Technology	Secondary Education, Teacher – 25-2031

Derived from: Spring 2017 NACE Salary Survey Report. NCES Data from 2009-2016. BLS occupations were selected based on occupational job descriptions published in the yearly BLS Occupational Outlook Handbook for 2016.

Research Limitations

Opportunity cost will be investigated and measured in terms of the starting and median salaries forgone when choosing a STEM teaching career instead of a STEM non-teaching career. This analysis is an initial step in what can become a robust analysis of opportunity cost for making career choices. As mentioned in Chapter 2, the literature examining the opportunity cost of teaching is limited, especially for STEM teachers. Having data that more thoroughly encompasses the value of benefits, time off, salary growth, job security, and other factors than impact career choice would improve this study. However, efforts were made to adjust for data limitations.

If the BLS were able to utilize methods to annualize median salary data and encompass other aspects of the salary and benefit package for different occupations, it would assist in creating a more useful dataset. If the quality of supplied data progresses, then the analysis of the opportunity cost of STEM teaching could be conducted more accurately.

Moreover, the interview process will expose individual responses to why teachers teach rather than work in industry, but individual responses to interviews cannot necessarily predict the responses of all STEM credentialed secondary school teachers.

Summary

This study will compare compatible STEM non-teaching careers with STEM teaching careers to determine the statistical significance of starting salaries for both career paths and the opportunity cost of STEM teaching at both the starting salary level and the median salary level for give STEM careers.

This research will have the following three benefits: (a) it will benefit individuals with STEM bachelor degrees in choosing a career; (b) it will benefit career counselors is aiding college students toward career options; and (c) it will aid policy makers in determining appropriate salary structures to recruit the types and level of STEM educated teachers to the teacher labor market.

While research has been conducted to measure teacher salaries in comparison with other bachelor's degree holder's salaries, specific analysis of the opportunity costs associated with choosing a STEM teaching career needs further analysis. This study attempts to analyze the opportunity costs of choosing a STEM teaching career in comparison with another STEM career outside of the classroom. This is an important first step to measure what is forgone, in terms of starting salary and median salary for individuals with a bachelor's degree in a STEM field who choose teaching as a career.

Chapter 4

Findings

Salary statistics reported in the Occupational Outlook Handbook (BLS, 2016) related to types of STEM professionals, when compared with salary statistics for STEM teachers, reveal that STEM professionals do appear to make more than similarly qualified STEM teaching professionals.

Table 5 shows median salaries for various types of STEM professionals, compared with salaries for secondary teachers. This table illustrates salaries as they were reported, compared with salaries adjusted to a 10-month schedule as discussed in Chapter 3.

Table 5. Stem Starting Salary Comparison between teaching and non-teaching positions.

Year	**Non-Teaching Annual Salary**	**STEM 10 Month Salary**	**Secondary Education**	**Opportunity Cost of Teaching**
2009	*$54,112.73*	*$45,093.94*	*$38,500.00*	*$6,593.94*
2010	*$54,910.91*	*$45,759.09*	*$36,070.00*	*$9,689.09*
2011	*$55,983.64*	*$46,653.03*	*$40,100.00*	*$6,553.03*
2012	*$56,330.91*	*$46,942.42*	*$37,970.00*	*$8,972.42*
2013	*$57,578.18*	*$47,981.82*	*$38,850.00*	*$9,131.82*
2014	*$56,758.18*	*$47,298.48*	*$38,580.00*	*$8,718.48*
2015	*$57,324.55*	*$47,770.45*	*$37,720.00*	*$10,050.45*
2016	*$57,432.55*	*$47,860.45*	*$36,489.00*	*$11,371.45*
Mean	*$56,304*	*$46,919.96*	*$38,035*	*$8,885*

This chapter presents the results of analyses and findings to address the research questions concerning the opportunity cost of choosing to teach high school STEM classes instead of entering a non-teaching STEM profession. The first research question was addressed by reviewing starting salary data for STEM professionals both inside and outside of education. STEM salaries for teachers are represented as annual salaries, but typical teaching contracts are based on ten-months of work. Therefore, annual salaries for STEM non-teaching professionals are adjusted to 10-month salaries. This adjustment was done by taking the reported annual salary, dividing it by 12 and then multiplying it by 10. Data was collected from NCES and NACE data systems.

The second research question was addressed by reviewing median salary data for STEM professionals both inside and outside of education. STEM salaries for teachers are represented as annual salaries, but typical teaching contracts are based on ten-months of work. Therefore, annual salaries for STEM non-teaching professionals are adjusted to 10-month salaries. This adjustment was done by taking the reported annual salary, dividing it by 12 and then multiplying it by 10. This analysis includes all levels of education and experience, not just starting salaries for bachelor’s degree holding individuals. This analysis presents salary differentials that express a more complete picture of whole career opportunity costs in terms of salary for STEM teachers versus non-teaching STEM professionals.

The third research question was addressed by gathering insight from current teachers of STEM high school classes and why they teach. This insight helps explain that the individual opportunity costs of teaching may not be strictly salary based.

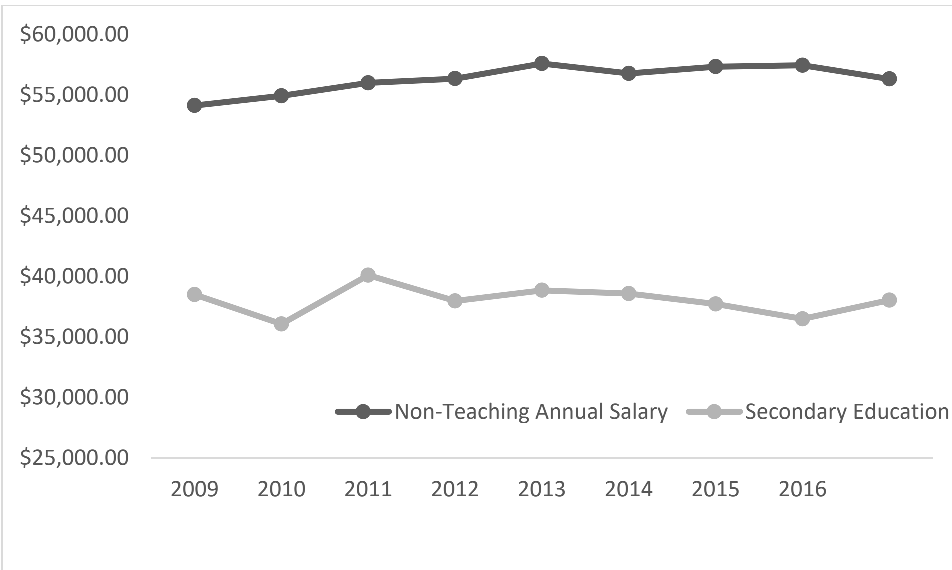
Research Question 1

Research question 1 asked, *Is there a difference between starting STEM teaching salaries and starting STEM non-teaching salaries?*

Salary Plots

In order to evaluate the difference between starting STEM teaching and STEM non-teaching salaries the first step was to create a salary plot of median salaries to determine what, if any, differences exist between teaching and non-teaching starting STEM salaries. The results are shown in Figure 1.

Figure 1. Comparison of initial teaching and non-teaching STEM majors salaries from 2009 to 2016.



Close examination shows gaps between non-teaching and teaching salaries for STEM majors in all categories except for Science majors which were markedly closer to teaching salaries on an annual basis. The average starting salary for a non-teaching STEM major was $56,304 (SD = $1,253.04) per year and the average STEM starting teaching salary was $38,035 (SD = $1298.16). The average difference between STEM non-teachers and STEM teachers annually was $18,269 for starting salaries for all years shown.

This trend continues even when adjusting salaries to be based on a 10-month schedule. The gap between non-teaching STEM majors and teaching STEM majors does reduce, however, the average starting 10-month salary for STEM non-teaching majors is $46,919 (SD = $1,044.20), compared to the unchanged $38,035 (SD = $1298.16) starting salary for STEM teachers as shown in Table 5. The difference in the average starting salaries between STEM non-teaching positions and STEM teaching positions is $8,884. Whether based on a 10-month salary or a 12-month salary there are differences ranging from $8,884 on average to $18,269. These differences are real losses, as expressed in unearned income, for those who choose to teach in public schools versus pursuing an initial career in the private STEM sector.

Research Question 2A

Research question 2A asked, *What is the opportunity cost of choosing to be a high school STEM teacher, as measured by a comparison of initial salary of new STEM teachers and non-teaching STEM professionals upon the completion of an undergraduate degree?* The analysis of measuring opportunity cost for initial salaries for STEM teaching and non-teaching was partially conducted in the answer to research question 1 which asked about starting salary differences. In terms of differences for STEM non-teaching versus STEM teaching initial salaries, overall there is a difference of $8,884 between STEM non-teachers and STEM teachers. In terms of forgone salary, on average, the opportunity cost of teaching is $8,884 for those holding a STEM degree as shown in Table 5.

However, when the STEM fields are looked at individually and not as an average, the opportunity costs vary when compared to STEM teaching. When STEM majors are broken down they include the following: *Science: Biology, Physical Science, and Environmental Science; Technology: Computer and Information Systems; Engineering: Chemical, Civil, Computer, Electrical, and Mechanical; Mathematics: Mathematics and Accounting*. Each of these categories offer unique opportunity costs when compared to teaching in a STEM field. In order to fully analyze the differences in salary, and therefore the opportunity costs of teaching, a full review of each category will be conducted.

The Opportunity Cost of Teaching with a Science Degree

Analysis of the science category includes the following majors: Biology, Physical Science, and Environmental Science. To analyze the opportunity cost of teaching versus working in a field with a Science degree requires the use of a linear plot. Figure 2 is a linear plot for the ten-month salary for initial salaries within the non-teaching Science industry and STEM teachers. It is interesting to note that for Science majors, the opportunity cost of teaching is negative, meaning that teaching offers a higher salary, on average, than non-teaching. The average difference for the years between starting salaries for teachers and non-teachers is $2803 (SD = $298). For this industry, teachers earn higher salaries over a ten-month period than do non-teachers with Science degrees. The average starting salary for a non-teaching Science major is $35,231 and the average starting salary for a teaching Science major is $38,035 as shown in Table 6.

Figure 2. Comparison of Initial Teaching Salary versus Non-Teaching Salary for Science Majors

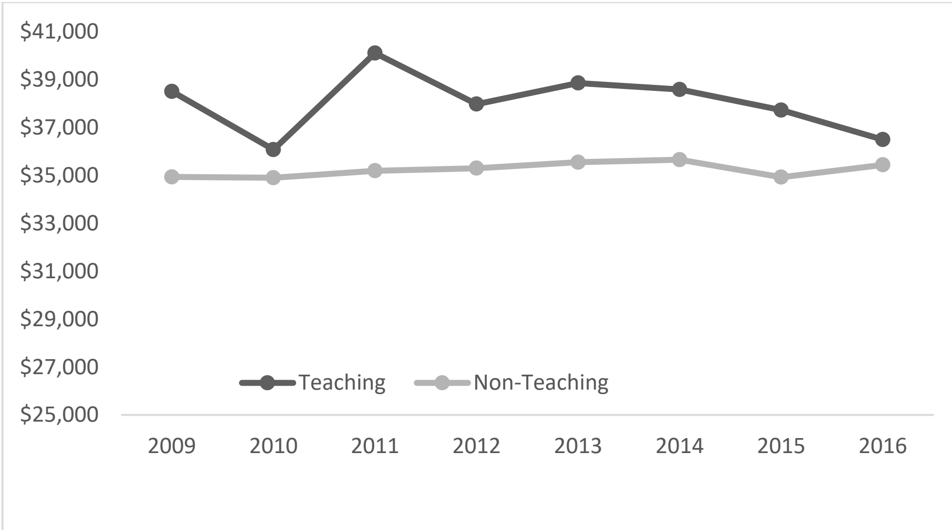


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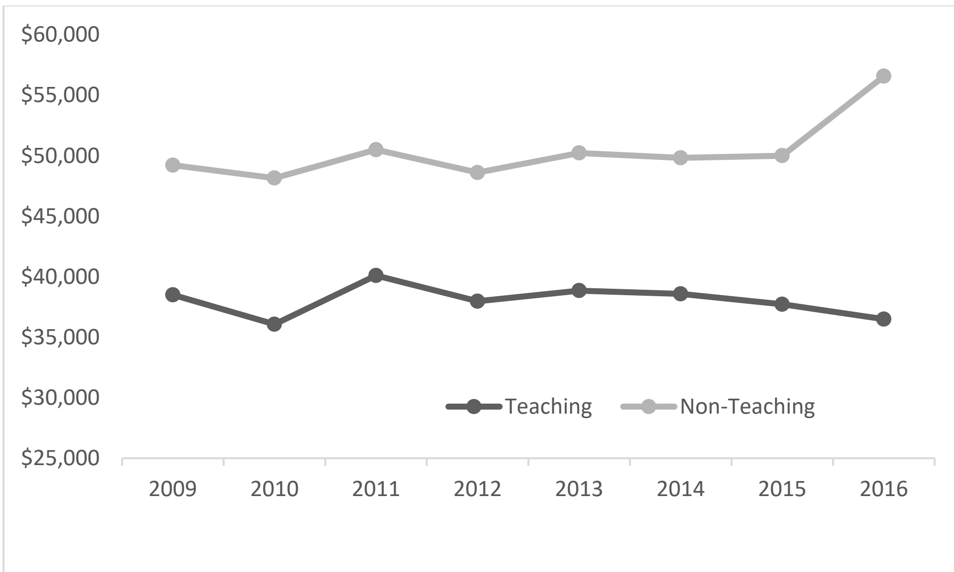
Table 6. Initial Salaries from 2009 to 2016 for Science Careers and Secondary Teachers

Year	**Biology**	**Environmental**	**Physical**	**Teaching**	**Science Average**	**Opportunity Cost of Teaching**
2009	*$35,267*	*$32,700*	*$36,825*	*$38,500*	*$34,930.56*	*-$3,569.44*
2010	*$36,083*	*$33,417*	*$35,192*	*$36,070*	*$34,897.22*	*-$1,172.78*
2011	*$35,600*	*$31,900*	*$38,058*	*$40,100*	*$35,186.11*	*-$4,913.89*
2012	*$35,442*	*$32,917*	*$37,525*	*$37,970*	*$35,294.44*	*-$2,675.56*
2013	*$37,650*	*$32,083*	*$36,900*	*$38,850*	*$35,544.44*	*-$3,305.56*
2014	*$37,658*	*$32,775*	*$36,517*	*$38,580*	*$35,650.00*	*-$2,930.00*
2015	*$35,875*	*$33,192*	*$35,692*	*$37,720*	*$34,919.44*	*-$2,800.56*
2016	*$34,792*	*$33,583*	*$37,923*	*$36,489*	*$35,432.50*	*-$1,056.50*
Average	*$36,046*	*$32,821*	*$36,829*	*$38,035*	*$35,231.84*	*-$2,803.03*

The Opportunity Cost of Teaching with a Technology Degree

Analysis of the technology category includes the following major: Computer and Information Systems. To analyze the opportunity cost of teaching versus working in a field with a Technology degree requires the use of a linear plot. Figure 3 is a linear plot for the ten-month salary for initial salaries within the non-teaching Technology industry and STEM teachers.

Figure 3. Comparison of Initial Teaching Salary versus Non-Teaching Salary for Technology Majors



The initial analysis indicates that for Technology majors, the opportunity cost of teaching is positive, meaning that not teaching offers a higher salary, on average, than teaching. The average difference for the years between starting salaries for teachers and non-teachers is $12,351 (SD = $3193). For this industry, non-teachers earn higher salaries over a ten-month period than do teachers with Technology degrees. The average starting salary for a non-teaching Technology major is $50,386 and the average starting salary for a teaching Technology major is $38,035 as shown in Table 7.

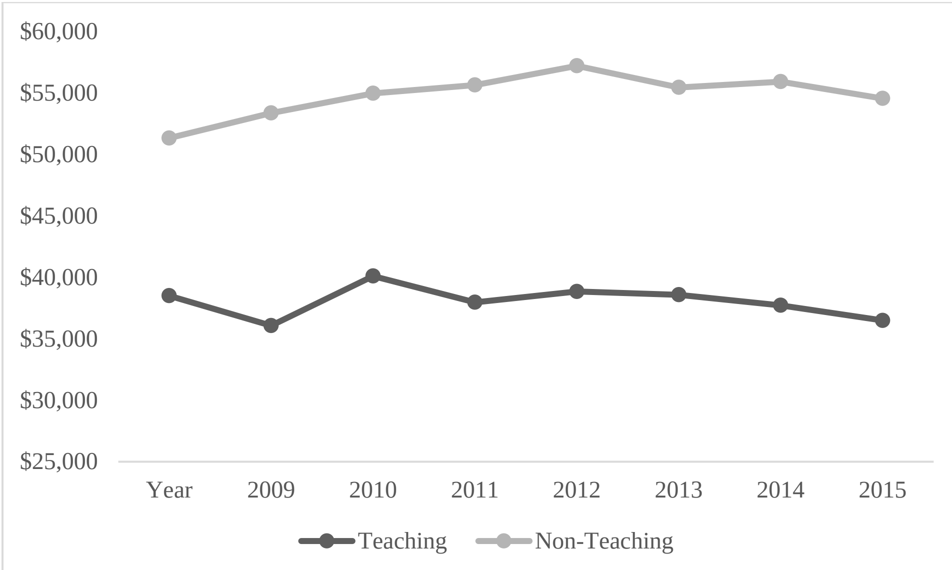
Table 7. Initial Salaries from 2009 to 2016 for Technology Careers and Secondary Teachers

Year	**Teaching**	**Computer and Information Systems**	**Opportunity Cost of Teaching**
2009	*$38,500*	*$49,217*	*$10,716.67*
2010	*$36,070*	*$48,150*	*$12,080.00*
2011	*$40,100*	*$50,500*	*$10,400.00*
2012	*$37,970*	*$48,608*	*$10,638.33*
2013	*$38,850*	*$50,225*	*$11,375.00*
2014	*$38,580*	*$49,825*	*$11,245.00*
2015	*$37,720*	*$50,000*	*$12,280.00*
2016	*$36,489*	*$56,567*	*$20,077.67*
Average	*$38,035*	*$50,386.46*	*$12,351.58*

The Opportunity Cost of Teaching with an Engineering Degree

Analysis of the engineering category includes the following majors: Chemical, Civil, Computer, Electrical, and Mechanical Engineering. To analyze the opportunity cost of teaching versus working in a field with an Engineering degree requires the use of a linear plot. Figure 4 is a linear plot for the ten-month salary for initial salaries within the non-teaching Mathematics industry and STEM teachers.

Figure 4. Comparison of Initial Teaching Salary versus Non-Teaching Salary for Engineering Majors



The initial analysis indicates that for engineering majors, the opportunity cost of teaching is positive, meaning that not teaching offers a higher salary, on average, than teaching. The average difference for the years between starting salaries for teachers and non-teachers is $16,771 (SD = $1944). For this industry, non-teachers earn higher salaries over a ten-month period than do teachers with Engineering degrees. The average starting salary for a non-teaching Engineering major is $54,806 and the average starting salary for a teaching Engineering major is $38,035 as shown in Table 8.

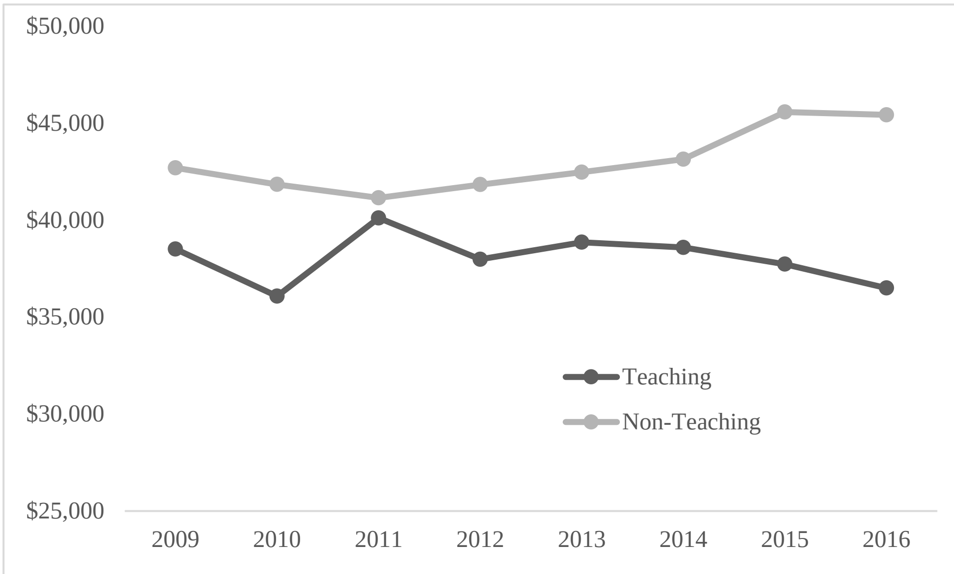
Table 8. Initial Salaries from 2009 to 2016 for Engineering Careers and Secondary Teachers

Year	Chemical	Civil	Computer	Electircal	Mechanical	Teaching	Engineering Average	Opportunity Cost of Teaching
2009	*$54,133*	*$48,225*	*$49,942*	*$53,008*	*$51,350*	*$38,500*	*$51,331.67*	*$12,831.67*
2010	*$56,750*	*$49,600*	*$54,725*	*$54,292*	*$51,483*	*$36,070*	*$53,370.00*	*$17,300.00*
2011	*$57,067*	*$47,592*	*$63,083*	*$52,750*	*$54,358*	*$40,100*	*$54,970.00*	*$14,870.00*
2012	*$58,508*	*$49,708*	*$58,158*	*$57,567*	*$54,292*	*$37,970*	*$55,646.67*	*$17,676.67*
2013	*$58,750*	*$49,167*	*$62,400*	*$58,625*	*$57,083*	*$38,850*	*$57,205.00*	*$18,355.00*
2014	*$56,283*	*$49,467*	*$58,433*	*$56,850*	*$56,225*	*$38,580*	*$55,451.67*	*$16,871.67*
2015	*$57,642*	*$49,900*	*$56,708*	*$59,675*	*$55,675*	*$37,720*	*$55,920.00*	*$18,200.00*
2016	*$57,578*	*$49,479*	*$58,322*	*$54,958*	*$52,438*	*$36,489*	*$54,554.83*	*$18,065.83*
Average	*$57,089*	*$49,142*	*$57,721*	*$55,966*	*$54,113*	*$38,035*	*$54,806.23*	*$16,771.35*

The Opportunity Cost of Teaching with a Mathematics Degree

Analysis of the mathematics category includes the following majors: Mathematics and Accounting. To analyze the opportunity cost of teaching versus working in a field with a Mathematics degree requires the use of a linear plot. Figure 5 is a linear plot for the ten-month salary for initial salaries within the non-teaching Mathematics industry and STEM teachers.

Figure 5. Comparison of Initial Teaching Salary versus Non-Teaching Salary for Mathematics Majors



The initial analysis indicates that for Mathematics majors, the opportunity cost of teaching is positive, meaning that not teaching offers a higher salary, on average, than teaching. The average difference for the years between starting salaries for teachers and non-teachers is $4,968 (SD = $2503). For this industry, non-teachers earn higher salaries over a ten-month period than do teachers with Mathematics degrees. The average starting salary for a non-teaching Mathematics major is $43,003 and the average starting salary for a teaching Mathematics major is $38,035 as shown in Table 9.

Table 9. Initial Salaries from 2009 to 2016 for Mathematics Careers and Secondary Teachers

Year	**Mathematics**	**Accounting**	**Teaching**	**Mathematics Average**	**Opportunity Cost of Teaching**
2009	*$44,058*	*$41,308*	*$38,500*	*$42,683.33*	*$4,183.33*
2010	*$41,833*	*$41,825*	*$36,070*	*$41,829.17*	*$5,759.17*
2011	*$42,367*	*$39,908*	*$40,100*	*$41,137.50*	*$1,037.50*
2012	*$43,492*	*$40,150*	*$37,970*	*$41,820.83*	*$3,850.83*
2013	*$45,542*	*$39,375*	*$38,850*	*$42,458.33*	*$3,608.33*
2014	*$44,283*	*$41,967*	*$38,580*	*$43,125.00*	*$4,545.00*
2015	*$45,425*	*$45,692*	*$37,720*	*$45,558.33*	*$7,838.33*
2016	*$43,793*	*$47,033*	*$36,489*	*$45,413.33*	*$8,924.33*
Average	*$43,849*	*$42,157*	*$38,035*	*$43,003.23*	*$4,968.35*

The Opportunity Costs of Teaching in Terms of Starting Salaries

Through analysis of individual categories of STEM majors, it is clear than in three of the four categories the opportunity cost of teaching is between $4,968 and $16,771 depending on the non-teaching industry. With the exception of Science majors where teaching offers on average a higher salary by $2803 over a ten-month period. The opportunity cost of teaching, as measured by the average salary difference between the STEM category salary and teaching salary, is expressed for each industry and major in Table 10.

Table 10. Opportunity Cost of Teaching by College Major for Initial Salaries, 2009-2016.

Year	**Opportunity Cost of Teaching - Science Majors**	**Opportunity Cost of Teaching - Technology Majors**	**Opportunity Cost of Teaching - Engineering Majors**	**Opportunity Cost of Teaching - Math Majors**
2009	*-$3,569.44*	*$10,716.67*	*$12,831.67*	*$4,183.33*
2010	*-$1,172.78*	*$12,080.00*	*$17,300.00*	*$5,759.17*
2011	*-$4,913.89*	*$10,400.00*	*$14,870.00*	*$1,037.50*
2012	*-$2,675.56*	*$10,638.33*	*$17,676.67*	*$3,850.83*
2013	*-$3,305.56*	*$11,375.00*	*$18,355.00*	*$3,608.33*
2014	*-$2,930.00*	*$11,245.00*	*$16,871.67*	*$4,545.00*
2015	*-$2,800.56*	*$12,280.00*	*$18,200.00*	*$7,838.33*
2016	*-$1,056.50*	*$20,077.67*	*$18,065.83*	*$8,924.33*
Average	*-$2,803.03*	*$12,351.58*	*$16,771.35*	*$4,968.35*

Research Question 2B

Research question 2B asked, *What is the opportunity cost of choosing to be a high school STEM teacher, as measured by a comparison of median salary of STEM teachers and non-teaching STEM professionals at all levels of experience and education level?* The analysis of measuring opportunity cost for salaries for STEM teaching and non-teaching has been addressed for initial salaries with the analysis for research question 2A.

That analysis intended to determine initial opportunity cost in terms of forgone salary for a recent college graduate and their initial choosing of a career. However, further analysis is needed to determine the opportunity cost over the course of a career. An initial analysis of STEM teaching salaries compared to salaries of STEM careers shows that there is a difference of $28,950 between STEM non-teachers and STEM teachers on an annual basis. In terms of forgone salary, on average, the opportunity cost of teaching is $14,924 annually for those holding a STEM degree as shown in Table 11.

Table 11. Stem Median Salary Comparison between teaching and non-teaching positions.

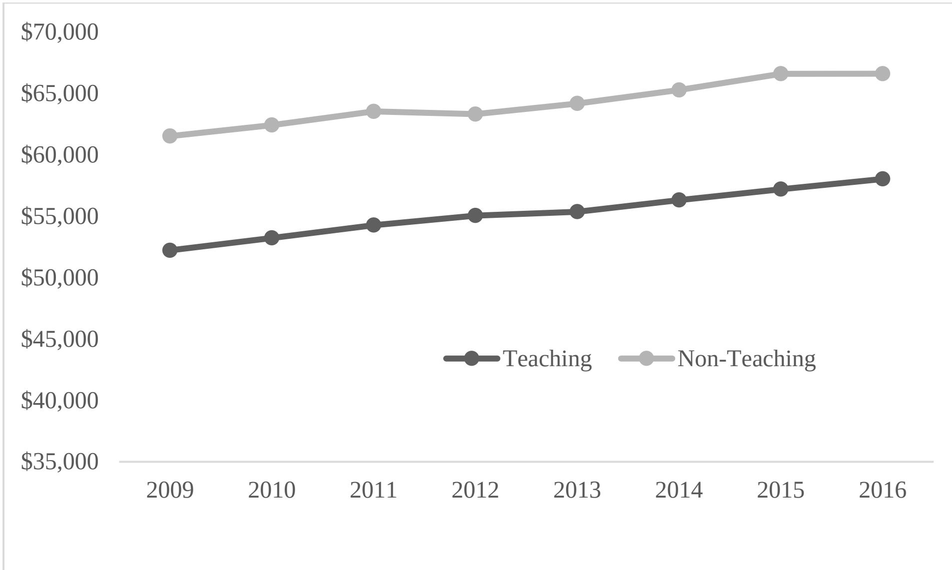
Year	STEM Annual Salary	STEM 10 Month Salary	Secondary Education	Opportunity Cost of Teaching
2009	*$79,282.73*	*$66,068.94*	*$52,220*	*$13,848.94*
2010	*$80,764.55*	*$67,303.79*	*$53,230*	*$14,073.79*
2011	*$82,031.82*	*$68,359.85*	*$54,270*	*$14,089.85*
2012	*$82,927.27*	*$69,106.06*	*$55,050*	*$14,056.06*
2013	*$84,404.55*	*$70,337.12*	*$55,360*	*$14,977.12*
2014	*$86,765.45*	*$72,304.55*	*$56,310*	*$15,994.55*
2015	*$88,337.27*	*$73,614.39*	*$57,200*	*$16,414.39*
2016	*$88,760.00*	*$73,966.67*	*$58,030*	*$15,936.67*
Mean	*$84,159*	*$70,133*	*$55,209*	*$14,924*

However, when the STEM fields are looked at individually and not as an average, the opportunity costs vary when compared to STEM teaching. When STEM majors are broken down they include the following: *Science: Biology, Physical Science, and Environmental Science; Technology: Computer and Information Systems; Engineering: Chemical, Civil, Computer, Electrical, and Mechanical; Mathematics: Mathematics and Accounting*. Each of these categories offer unique opportunity costs when compared to teaching in a STEM field. In order to fully analyze the differences in salary, and therefore the opportunity costs of teaching, a full review of each category will be conducted.

The Opportunity Cost of Teaching with a Science Degree

Analysis of the science category includes the following majors: Biology, Physical Science, and Environmental Science. To analyze the opportunity cost of teaching versus working in a field with a Science degree requires the use of a linear plot. Figure 6 is a linear plot for the ten-month salary for median salaries within the non-teaching Science industry and STEM teachers.

Figure 6. Comparison of Median Teaching Salary versus Non-Teaching Salary for Science Majors



The initial analysis indicates that for Science majors, the opportunity cost of teaching is positive, meaning that not teaching offers a higher salary, on average, than teaching. The average difference for the years between median salaries for teachers and non-teachers is $8969 (SD = $397). For this industry, teachers earn lower salaries over a ten-month period than do non-teachers with Science degrees. The average median salary for a non-teaching Science major is $64,178 and the average median salary for a teaching Science major is $55,209 as shown in Table 12.

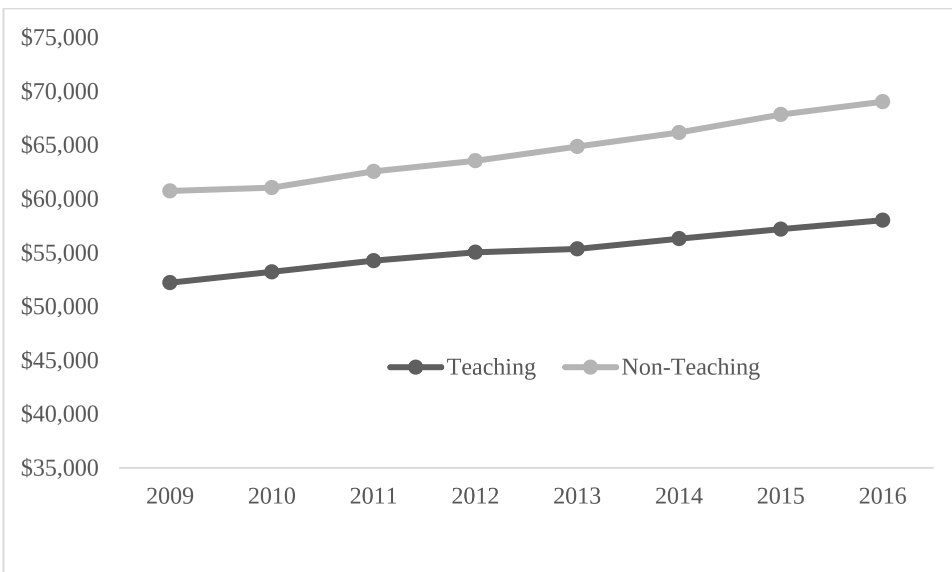
The Opportunity Cost of Teaching with a Technology Degree

Analysis of the technology category includes the following major: Computer and Information Systems. To analyze the opportunity cost of teaching versus working in a field with a Technology degree requires the use of a linear plot. Figure 7 is a linear plot for the ten-month salary for median salaries within the non-teaching Technology industry and STEM teachers.

Table 12. Median Salaries from 2009 to 2016 for Science Careers and Secondary Teachers

Year	**Biology**	**Environmental**	**Physical**	**Teaching**	**Science Average**	**Opportunity Cost of Teaching**
2009	*$55,425*	*$50,842*	*$78,292*	*$52,220*	*$61,519*	*$9,299*
2010	*$56,850*	*$51,417*	*$78,983*	*$53,230*	*$62,417*	*$9,187*
2011	*$58,992*	*$52,433*	*$79,158*	*$54,270*	*$63,528*	*$9,258*
2012	*$60,583*	*$52,975*	*$76,367*	*$55,050*	*$63,308*	*$8,258*
2013	*$60,600*	*$54,242*	*$77,692*	*$55,360*	*$64,178*	*$8,818*
2014	*$62,267*	*$55,208*	*$78,358*	*$56,310*	*$65,278*	*$8,968*
2015	*$62,625*	*$56,217*	*$80,942*	*$57,200*	*$66,594*	*$9,394*
2016	*$62,325*	*$57,425*	*$80,058*	*$58,030*	*$66,603*	*$8,573*
Average	*$59,958*	*$53,845*	*$78,731*	*$55,209*	*$64,178.13*	*$8,969.38*

Figure 7. Comparison of Median Teaching Salary versus Non-Teaching Salary for Technology Majors



The initial analysis indicates that for Technology majors, the opportunity cost of teaching is positive, meaning that not teaching offers a higher salary, on average, than teaching. The average difference for the years between median salaries for teachers and non-teachers is $9,280 (SD = $1169). For this industry, teachers earn lower salaries over a ten-month period than do non-teachers with Technology degrees. The average median salary for a non-teaching Technology major is $64,489 and the average median salary for a teaching Technology major is $55,209 as shown in Table 13.

Table 13. Median Salaries from 2009 to 2016 for Technology Careers and Secondary Teachers

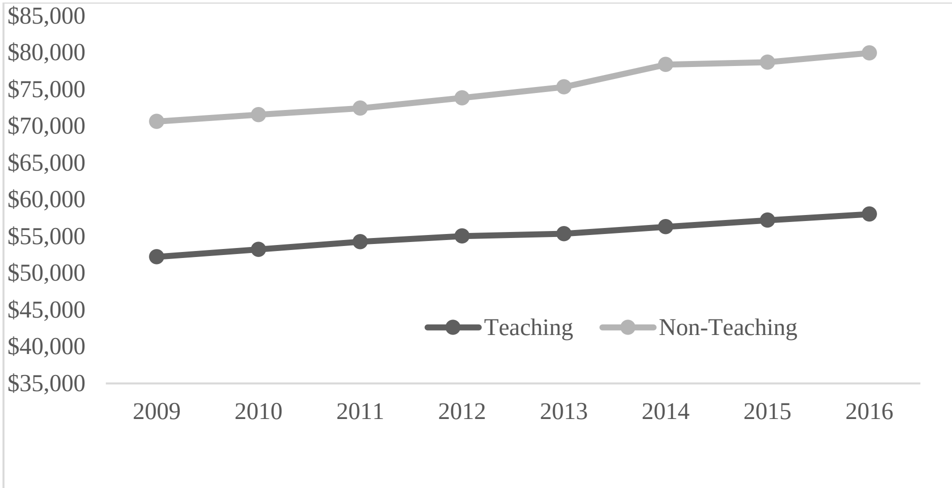
Year	**Technology**	**Teaching**	**Opportunity Cost of Teaching**
2009	*$60,750*	*$52,220*	*$8,530*
2010	*$61,058*	*$53,230*	*$7,828*
2011	*$62,567*	*$54,270*	*$8,297*
2012	*$63,558*	*$55,050*	*$8,508*
2013	*$64,883*	*$55,360*	*$9,523*
2014	*$66,183*	*$56,310*	*$9,873*
2015	*$67,858*	*$57,200*	*$10,658*
2016	*$69,050*	*$58,030*	*$11,020*
Average	*$64,489*	*$55,209*	*$9,280*

The Opportunity Cost of Teaching with an Engineering Degree

Analysis of the engineering category includes the following majors Chemical, Civil, Computer, Electrical, and Mechanical Engineering. To analyze the opportunity cost of teaching versus working in a field with an Engineering degree requires the use of a linear plot. Figure 8 is a linear plot for the ten-month salary for median salaries within the non-teaching Engineering industry and STEM teachers.

The initial analysis indicates that for engineering majors, the opportunity cost of teaching is positive, meaning that not teaching offers a higher salary, on average, than teaching. The average difference for the years between median salaries for teachers and non-teachers is $19,903 (SD = $1704).

Figure 8. Comparison of Median Teaching Salary versus Non-Teaching Salary for Engineering Majors



For this industry, teachers earn lower salaries over a ten-month period than do non-teachers with an Engineering degree. The average median salary for a non-teaching Engineering major is $75,112 and the average median salary for a teaching Engineering major is $55,209 as shown in Table 14.

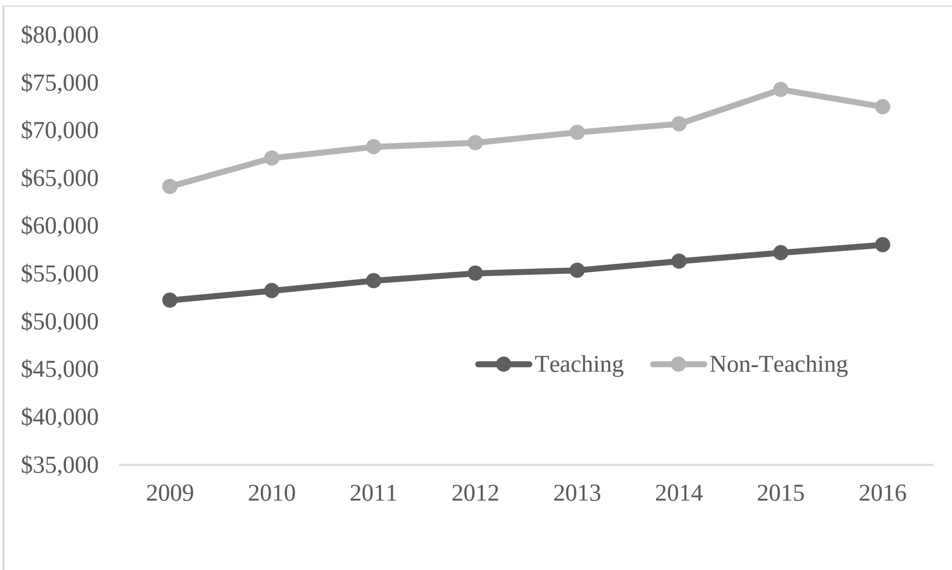
Table 14. Median Salaries from 2009 to 2016 for Engineering Careers and Secondary Teachers

Year	Chemical	Civil	Computer	Electrical	Mechanical	Average	Secondary Education	Opportunity Cost of Teaching
2009	$73,567	*$63,825*	*$82,350*	*$69,258*	*$64,183*	*$70,637*	*$52,220*	*$18,417*
2010	$75,250	*$64,633*	*$82,342*	*$70,450*	*$65,133*	*$71,562*	*$53,230*	*$18,332*
2011	$77,442	*$64,992*	*$82,175*	*$71,600*	*$66,025*	*$72,447*	*$54,270*	*$18,177*
2012	$78,625	*$66,117*	*$84,100*	*$73,267*	*$67,150*	*$73,852*	*$55,050*	*$18,802*
2013	$79,775	*$67,308*	*$86,875*	*$74,317*	*$68,417*	*$75,338*	*$55,360*	*$19,978*
2014	$80,783	*$68,375*	*$90,358*	*$79,817*	*$72,617*	*$78,390*	*$56,310*	*$22,080*
2015	$81,133	*$68,517*	*$93,108*	*$81,117*	*$69,658*	*$78,707*	*$57,200*	*$21,507*
2016	$81,950	*$69,617*	*$95,900*	*$82,183*	*$70,158*	*$79,962*	*$58,030*	*$21,932*
Average	$78,566	*$66,673*	*$87,151*	*$75,251*	*$67,918*	*$75,112*	*$55,209*	*$19,903*

The Opportunity Cost of Teaching with a Mathematics Degree

Analysis of the mathematics category includes the following majors: Mathematics and Accounting. To analyze the opportunity cost of teaching versus working in a field with a Mathematics degree requires the use of a linear plot. Figure 9 is a linear plot for the ten-month salary for median salaries within the non-teaching Mathematics industry and STEM teachers.

Figure 9. Comparison of Median Teaching Salary versus Non-Teaching Salary for Mathematics Majors



The initial analysis indicates that for Mathematics majors, the opportunity cost of teaching is positive, meaning that not teaching offers a higher salary, on average, than teaching. The average difference for the years between median salaries for teachers and non-teachers is $14,230 (SD = $1422). For this industry, non-teachers earn higher salaries over a ten-month period than do teachers with Mathematics degrees. The average median salary for a non-teaching Mathematics major is $69,439 and the average median salary for a teaching Mathematics major is $55,209 as shown in Table 15.

Table 15. Median Salaries from 2009 to 2016 for Mathematics Careers and Secondary Teachers

Year	**Mathematics**	**Accounting**	**Teaching**	**Mathematics Average**	**Opportunity Cost of Teaching**
2009	*$77,983*	*$50,283*	*$52,220*	*$64,133.33*	*$11,913.33*
2010	*$82,817*	*$51,408*	*$53,230*	*$67,112.50*	*$13,882.50*
2011	*$84,200*	*$52,375*	*$54,270*	*$68,287.50*	*$14,017.50*
2012	*$84,467*	*$52,958*	*$55,050*	*$68,712.50*	*$13,662.50*
2013	*$85,367*	*$54,233*	*$55,360*	*$69,800.00*	*$14,440.00*
2014	*$86,433*	*$54,950*	*$56,310*	*$70,691.67*	*$14,381.67*
2015	*$92,592*	*$55,992*	*$57,200*	*$74,291.67*	*$17,091.67*
2016	*$88,175*	*$56,792*	*$58,030*	*$72,483.33*	*$14,453.33*
Average	*$85,254*	*$53,624*	*$55,209*	*$69,439.06*	*$14,230.31*

The Opportunity Cost of Teaching in Terms of Median Salaries

Through analysis of individual categories of STEM majors, it is clear that in all of the four categories the opportunity cost of teaching is positive, meaning that teachers forgo income to enter the classroom when choosing a career. The opportunity costs range from a low of $8969 for Science majors to a high of $19,903 for Engineering majors, which is the amount of lost income realized by individuals choosing to teach and forgo careers in non-teaching STEM fields. Over the course of a 35-year career that equated to lost income of between $313,915 to $696,605. The opportunity cost of teaching, as measured by the average salary difference between the STEM category salary and teaching salary, is expressed for each industry and major in Table 16.

Table 16. Comparison of Opportunity Cost for each College Major at the Median Salary Level

Year	Opportunity Cost of Teaching - Science Majors	Opportunity Cost of Teaching - Technology Majors	Opportunity Cost of Teaching - Engineering Majors	Opportunity Cost of Teaching - Math Majors
2009	*$9,299*	*$8,530*	*$18,417*	*$11,913.33*
2010	*$9,187*	*$7,828*	*$18,332*	*$13,882.50*
2011	*$9,258*	*$8,297*	*$18,177*	*$14,017.50*
2012	*$8,258*	*$8,508*	*$18,802*	*$13,662.50*
2013	*$8,818*	*$9,523*	*$19,978*	*$14,440.00*
2014	*$8,968*	*$9,873*	*$22,080*	*$14,381.67*
2015	*$9,394*	*$10,658*	*$21,507*	*$17,091.67*
2016	*$8,573*	*$11,020*	*$21,932*	*$14,453.33*
Average	*$8,969.38*	*$9,280*	*$19,903*	*$14,230.31*

Research Question 3

Research question three states, *What is the rationale for staying in teaching and how is individual opportunity cost measured?* To answer this question, I interviewed 4 current science teachers in a public school district north of Houston, TX. The interviews were conducted in a semi-structured manner. Because the opportunity costs of teaching, especially over the length of a career, are large there may be reasons beyond salary that individuals teach and forgo salary in alternative occupations.

The interviews were conducted in the setting of the subjects choosing. Two interviews were conducted face-to-face, while the other two were conducted over the phone. All interviews were recorded and transcribed. The transcriptions can be found in Appendix A. I analyzed the interview data using the thematic content analysis approach.

The thematic content analysis approach is designed to uncover themes in answers given by different respondents of similar or the same questions.

Individual Interview Analyses

Interview One

The first interview conducted was with a teacher who currently teaches advanced biology classes. The respondent has 16 years of classroom teaching experience in two different states. The respondent's undergraduate degree is in Microbiology with a minor in Chemistry and the individual has taught in both private and public schools, with the last 10 years serving in public schools in Texas.

The respondent did not consider teaching a career choice initially and worked in medical sales prior to teaching in Texas. However, the career was not as fulfilling and the respondent earned a teaching certificate as part of the respondent's undergraduate degree. The respondent indicated that even though their career has spanned 16 years as an educator it took the respondent, "a long time to say I like teaching." However, when asked what prompted the respondent to stay in the classroom as a teacher, the respondent indicated that working with students, making connections with people, and the ability to build relationships has helped the respondent.

The respondent indicated that initially, it was passion for science that drew the respondent to a teaching career, but that as the respondent's career has evolved it is working with students that has kept the respondent committed to the classroom. However, during the first four years of the respondent's career, the respondent considered leaving the profession. In the end though, the respondent committed to the career and was committed to working with student to further their understanding of science. The respondent indicated that veteran teachers at the schools the respondent has worked in have been instrumental in assisting the respondent in adhering to teaching as a career choice. When asked about the most rewarding experiences and most difficult parts of teaching as a career, the respondent's answers were connected to working with people. In terms of positive aspects of teaching, the respondent revealed several stories of working with students and hearing from former students who chose science as a college major or who are working in science as a career. Conversely, the most difficult part of teaching for this respondent was the kids that, "you lose." The respondent indicated that regardless of what the respondent did to try and make an effort to connect with a student, it was frustrating when the respondent could not. Moreover, the respondent indicated that when professional relationships with other adults were challenging, it made teaching as a career difficult.

> "A conversation I had with a teacher a couple of years ago, he wanted to be a doctor. He wasn't in medical school yet, he hated teaching, (and) when you come every day and have a bad day what you are choosing for kids is that they will never consider a career in any medical field because of the experience in this class…because kids will seek out (doing) things that they are good or comfortable at (doing) and that is very teacher based."

Interview Two

The second interview was conducted with a teacher who currently teaches advanced chemistry classes. The respondent has 13 years of public school teaching in the same school, all in Texas. The respondent's bachelor's degree is in Chemistry as is the respondent's master's degree. The respondent entered teaching through an alternative certification program after working in industry for several years prior to having a family. The respondent was inspired to enter into teaching after seeing the positive impact teachers had on the respondent's own children.

Initially, the respondent did not consider teaching as a career choice because of a strong interest in chemistry and financial concerns due to salary differentials between teaching and industry work. However, once the respondent began teaching the relationships built with students and colleagues have kept the respondent in the classroom, indicating that teaching was the respondent's true calling and that the respondent had no idea, initially, that would be the case.

In terms of who inspired this teacher, the respondent indicated that a mix of current professionals have impacted the respondent's own work as a teacher, but that the respondent's high school chemistry teacher inspired the respondent's love for the subject matter of chemistry. When asked whether it was working with students or teaching chemistry that motivates the respondent, the indication was that initially it was the subject matter, as the respondent has a strong passion for chemistry, but that it quickly became working with students and building those relationships that has motivated the respondent and kept the respondent in the classroom.

The respondent indicated that the most rewarding experiences of teaching is receiving an award for most inspirational teacher as voted on by the graduating class of the school. The most challenging part of teaching is working with students that are hard to reach. "When I don't get to inspire them – or even reach them a little bit – in the thing that I love so much (chemistry)…that is probably the hardest."

The respondent indicated that seeing the respondent's student pursue careers or majors in science is extremely rewarding. Moreover, when asked about the struggle to find good teachers, the respondent indicated that salary is a major factor that precludes those with the passion and ability to enter the teaching field. Finally, the respondent indicated that passion for working with students should be why people enter teaching, and that passion can be grown in teachers as they remain in the classroom.

Interview Three

The third interview was conducted with a respondent who currently teaches advanced and on-level biology classes. The respondent has five years of teaching experience, all in the same school in Texas. The respondent has a bachelor's degree in Biology and a master's degree in Curriculum and Instruction and the respondent entered the teaching field through an alternative certification process post-undergraduate graduation. The respondent indicated an interest in teaching from 6^{th} grade on, as the respondent always liked school and was good at school. In college the respondent was focused on pre-medicine; however, the respondent took advantage of education classes that were offered to science majors that would enable individuals to gain teacher certification in addition to the bachelor's degree in their major. The respondent did not complete certification prior to graduating with a degree in Biology.

When asked about what has kept the respondent in the classroom, the respondent indicated that a passion for science and teaching science. Moreover, the respondent indicated that positive feedback from students helps to keep the respondent in the classroom. Meanwhile, many of the respondent's non-educator colleagues have careers in medicine and other science based careers, the respondent indicated that there has never been serious thought to leaving education, as evidenced by the respondent's completion of a master's degree in the field of education.

The respondent indicated that teachers the respondent had when in high school helped influence the type of teacher the respondent is. The respondent indicated that originally it was a passion for science and biology specifically drew the respondent to teaching, but that now with several years of teaching experience it is working with youth that is a true motivating factor to continue teaching. The most rewarding experiences of teaching, as indicated by the respondent, are when the respondent receives feedback from students. Whilst the more challenging aspects of teaching are dealing with parents and other adults that question the respondent's intentions of being a champion for students.

Interview Four

The fourth interview was conducted with a respondent who currently teaches on level and advanced physics. The respondent has taught for 16 years in two different states, but has taught in Texas as a physics teacher for the last 10 years. The respondent has a bachelor's degree in chemistry and a master's degree in education administration. The respondent indicated that teaching was initially viewed as a three-to-four-year profession prior to getting a job in industry, but ended up enjoying "being paid to talk about physics." While the respondent has considered leaving the classroom, it would be to enter into administration rather than leave the field of education.

The respondent indicated that it is the passion for teaching science and the process of teaching science that keeps the respondent in the classroom. The respondent indicated that throughout the respondent's career there have been times when the idea of leaving the classroom to enter back into private industry crossed the respondent's mind, most of the desire to leave had to do with teaching challenging student and managing their behavior. When asked about role models in education that the respondent gained insight and guidance from the respondent indicated that a teacher, who has since retired, was instrumental in helping the respondent deliver content in a challenging way, but in a way that students would still be successful.

When asked about what motivated the respondent to teach, the respondent indicated that it was a love for the subject of physics and teaching it that initially motivated the respondent to become a teacher. However, the respondent admitted that as the respondent's career has evolved, the opportunity to work with students and help students has been more of a motivating factor than it was when the respondent first started teaching. The most challenging part of teaching for this respondent was working with student's that struggled or that were not able to academically invest in the work load. When asked if there was anything else the respondent wanted to add, the respondent indicated that the benefit of having individuals from private industry teach is a positive for schools and students. The respondent indicated that the practical experience brought from private industry to the classroom is a real-world benefit for students learning a challenging science curriculum.

Summary of Interview Responses

Question One: How did you first become interested in becoming a teacher? What was your experience in choosing teaching as a career?

In general respondents did not consider teaching as a career prior to achieving a bachelor's degree with the exception of respondent three. All respondents earned their teaching credentials either through alternative certification or after working a career outside of education.

Question Two: What has kept you in the classroom as a science teacher? Why do you continue to work in this profession?

Each respondent indicated that working with students and their subject matter is what keeps them in the classroom. None of the respondents indicated that they were actively pursuing leaving education for any reason, including salary differentials between teaching and private industry STEM careers.

Question Three: Have you ever considered leaving the classroom during your years as a teacher? What were those thoughts and what happened to eventually make you change your mind and stay in the classroom?

Respondent one and respondent four indicated that they had considered leaving education, but ultimately are satisfied with their decision to stay in education. Respondent two indicated no desire to consider leaving teaching. Respondent three considered alternative careers, but has not pursued alternative careers and would be surprised to have a career outside of education in the future.

Question Four: Did you have any role models or mentors that influenced your becoming a teacher or the way you work as a teacher? What can you say about their impact on your career?

All respondents indicated that other educators had significant impact on who they are as teachers. Respondent one, respondent two, and respondent four all stated that individuals that they have worked with or are currently working with influence who they are as teachers. Respondents two and three indicated teachers they had in high school influenced who they are as teachers.

Question Five: How important is the subject you teach to you being a teacher? Is it your passion for science that motivates you to teach or your passion for working with young people that motivates you?

All respondents indicated a passion for their subject matter and all indicated that is what initially drew them to teaching. Moreover, all indicated that after beginning their teaching careers, the ability to work with and influence students is a stronger motivator than just their subject matter alone.

Question Six: What have been your most rewarding experiences as a teacher? And conversely, what experiences have been the most depressing or discouraging?

Respondents one, two, and three indicated that building relationships with students and seeing students have success in and out of their discipline has been rewarding. Respondent four shared the same sentiment but included the ability to talk about physics all day and getting paid to do so as one of the rewarding experiences of teaching. Moreover, respondent four indicated that feedback from former students about the projects and practical learning that occurred in the respondent's classroom was a rewarding experience.

Respondent one and respondent two indicated that when they struggle building relationships with students in their classroom, and cannot inspire or create positive relationships that it is discouraging. Respondent three indicated, as well as did respondent one, that negative relationships with adults, whether they be colleagues or parents, is discouraging. Respondent four indicated similar sentiment to respondents one and two, but was more focused on student's that struggled with behavior and learning as being a more discouraging part of the job.

Question Seven: Are there any other comments or observations you would like to make about your work as a science teacher?

This broad question allowed for a variety of responses from the respondents, with the exception of respondent three who did not have anything else to add. Respondent one indicated that there is importance for the respondent in knowing that the subject matter the respondent teachers is important and will impact the future. Respondent two explained that there needs to be a passion to be an effective teacher and that if one is not passionate about the job – get out, because the money isn't good enough to justify doing a substandard job. Respondent four offered feedback about the importance of ensuring avenues of entering the teaching field for those with industry experience.

Summary of Findings

The analysis of opportunity cost at both the initial salary level for STEM bachelor degree holders and medial salary level for STEM careers indicates that salary differentials exist for those who enter teaching and forgo private industry in the field of their choice, with one exception: starting salary for Science Majors.

The starting salary differential for STEM careers versus teaching high school STEM courses is $8,885 based on a ten-month salary schedule. In other words, it will cost a first year teacher, in terms of lost salary, $8,885 on average to be a teacher rather than to work in private industry their first year out of college. This trend is true for every STEM major with the exception of Science majors who on an annual basis make more than teachers, but on a ten-month basis make less than teachers.

When comparing median salaries, there is an opportunity cost of teaching of $14,294 on average across all STEM majors based on a ten-month salary schedule. In other words, it will cost a teacher, in terms of lost salary, $14,294 on average to teach rather than to work in private industry at the median salary level. That is to say earlier in a career the differentials may be smaller, but that later in a career the differentials may be greater. Over a 35-year career as a teacher, that would equate to an aggregate opportunity cost of $500,290 in lost salary for a STEM teacher.

These salary differentials led me to interview current high school science teachers to determine why they choose to teach rather than to pursue careers in private industry. I interviewed four current teachers, all of who have a bachelor's degree in a STEM major, and a minimum of five years of teaching experience. All four entered teaching for different reasons but all have stayed in the classroom, and forgone salary, for one reason: teaching students. All four of the respondents indicated that the relationships they built with students, especially around the challenging curriculum of science education, perfectly blended their passion for the content with their desire to inspire students.

While evidence suggests that a teacher with a bachelor's degree in a STEM major may lose out on over $500,000 over the course of a career in education, the reason that teacher's stay in the classroom is the positive impact they have on the lives of students.

Chapter 5

Summary, Conclusions, and Recommendations

This chapter includes a summary of the findings, presents conclusions, and suggestions for further research.

Summary

The purpose of this study was to review the opportunity cost of teaching for STEM majors rather than pursuing a career in a STEM non-teaching field. Determination of the opportunity cost of teaching provides evidence for students to consider when selecting a major in college and help career counselors provide evidence to help students make career choices.

The following research questions guided the study:

1. Is there is a difference between starting STEM teaching salaries and starting STEM non-teaching salaries?

2. What is the opportunity cost of choosing to be a high school STEM teacher, as measured by (a) a comparison of initial salary of new STEM teachers and non-teaching STEM professionals upon the completion of an undergraduate degree, and (b) median salaries of STEM teachers and non-teaching STEM professionals at all levels of education and experience?

These research questions address two salary groupings: (a) starting salaries of newly graduated holders of bachelor's degrees, and (b) median salary data for all professionals in selected occupations.

3. What is the rationale for staying in teaching and how is individual opportunity cost measured? This will be evaluated by interviewing current high school STEM credentialed teachers and analyzing their responses to a semi-structured interview.

The literature relevant to this study was reviewed to place this research in context. The following areas were addressed: Teacher's Salaries; Teacher Attrition, Retention, and Recruitment Efforts; Opportunity Cost of Teaching; STEM Teaching; STEM Teacher Preparation, Induction, and Professional Development; STEM Teacher Retention and Turnover; and Career Choice.

This study explored the opportunity cost of teaching versus non-teaching STEM careers at both the initial years of an individuals' career and the median salary for STEM professions and secondary teaching. Moreover, the study explored individual STEM teacher's rationale for remaining in the classroom. Addressing the three research questions assisted in determining whether STEM teachers earn lower salaries than similarly educated STEM non-teaching professionals.

National salary data at both the initial career salary level and median salary levels for teaching and non-teaching STEM professions were collected and analyzed over the span of multiple years. Salary between data sets were chosen with consideration for degree level earned for initial salary comparisons. All data for initial salary comparisons were based on individuals that had earned a bachelor's degree only and individuals with no more than 5 years of work experience. Salary data for median earnings included all years of work experience and all levels of education including and beyond the bachelor degree level of education. Non-teaching STEM professional's salaries were adjusted to reflect a 10-month salary to be more similar to the working months of the teaching profession.

The first research question was addressed by conducting salary analysis through plot lines and analysis of 10-month and annual salaries. The initial analysis of this research question shows that there are differences between STEM teaching and STEM non-teaching professions at both the 12-month and 10-month salary levels. In general, STEM non-teaching initial salaries are higher than STEM teaching salaries. These gaps exist in all categories.

The second research question was answered by review opportunity costs of teaching at both the career entry level and median career levels in terms of salary.

Opportunity costs were determined by analyzing the difference in 10-month salary for non-teachers and teachers. A positive opportunity cost of teaching indicated that the differential in salary was such that teachers made less money than non-teachers for that category. A negative opportunity cost would indicate that a teacher earns more money on a 10-month salary basis that the non-teaching STEM professional.

Analysis of initial salary differences showed a positive opportunity costs for teaching versus non-teaching with the exception of those with a bachelor degree in Science. Those with degrees in Science made more on an annual basis, but less on the adjusted 10-month salary basis. A similar pattern, but with more dramatic opportunity costs surfaces when analyzing the data for median salaries of STEM teachers and STEM non-teaching professionals. However, in the median salary analysis there are no categories for which teaching has a negative opportunity cost.

The third research question investigated the rationale of teachers who have stayed with teaching despite the clear opportunity costs of salary. This analysis indicated that these teachers, while motivated to enter teaching for different reasons, continue to teach because of the positive relationships they build with students and their passion for helping students understand the complexities of STEM disciplines.

Conclusions

Empirical analysis reported in this study of STEM teachers' salaries compared to salaries of similarly qualified non-teaching STEM professionals shows that STEM teachers do sacrifice income in order to teach, supporting the conventional wisdom. While starting salaries between teachers and non-teachers are closer on average, as careers evolve the incomes earned over a career for a STEM teacher compared to a non-teaching STEM professional showcase losses in salary for teachers within the range of $300,000-$600,000 over 35 years.

An understanding of the rationale of teachers who stayed within the profession indicated that teachers who forgo higher salaries in private STEM industries, indicates that the value of impacting students positively and building positive relationships with students in the confines of a rich STEM curriculum is worth $15,000 per year on average, in economic terms.

One of the implications of this study is that analysis like this can improve the knowledge and information available to STEM majors who are considered entering into teaching. This analysis indicates that the national salary data supports the notion that compared to other STEM professions STEM teachers are paid significantly less over the course of a career. College students, career counselors, and other influential individuals that impact career choice need to be aware that while a rewarding career, as indicated by the interviewee responses, teaching will earn individuals less income over their teaching career than alternative career choices.

Recommendations

These results are intended to guide STEM bachelor degree holders when considering a career in industry or education. Many universities and colleges, in response to shortages in qualified mathematics and science teachers, offer students within colleges that offer STEM bachelor degrees the opportunity to graduate with a degree and a teacher certification at no or limited cost to the student. When considering the binary choice between teaching and industry, the results show that industry will offer a higher salary, on a ten-month basis, at all stages of a STEM major’s career, with the exception of Science bachelor degree holders in the initial year of a career. This study attempted to calculate the opportunity cost of teaching, in terms of forgone salary from not working in industry, for STEM bachelor degree holders. The following are recommendations for further study:

1. What are the other benefits and aspects of compensation for teaching and industry work outside of salary?

2. Are the same results for opportunity cost supported at all levels of teaching? For example, teaching elementary school, middle school, or college level courses?

3. What are the results at a state level? Every state has teachers, but not every state may employ petroleum engineers or chemical engineers? Is the opportunity cost spread between teaching and industry sensitive to geography?

4. Do similar opportunity costs exist for those individuals with non-STEM degrees such as English Literature or History? How do those salary differentials impact the overall teaching market and setting teacher salaries?

5. Would differentiated teacher salaries for the degree held affect the market for teachers (a) overall; and (b) for STEM related teaching positions? In other words, if engineering majors made more money than English majors to teach, would that induce more engineering majors to enter the classroom?

6. What, if any, impact does the business cycle have on teacher markets, especially when employment markets for STEM majors contract? Does it induce more STEM bachelor degree holders into education? What is the retention rate for those teachers?

7. There is a notion of those who can’t be successful in industry end up as teachers. For STEM bachelor degree holders who choose to teach rather than work in industry, is there a difference in quality of graduate as measured by GPA in STEM field?

References

Amrein-Beardsley, A. (2007). Recruiting Expert Teachers into Hard-to-Staff Schools. *Education Digest*, *73*(4), 40–44.

Auguste, S. | B., Kihn, P., & Miller, M. (2010). Closing the talent gap: Attracting and retaining top third graduates to a career in teaching. Retrieved August 2, 2015, from http://mckinseyonsociety.com/closing-the-talent-gap/

Bacolod, M. (2007). Who Teaches and Where They Choose to Teach: College Graduates of the 1990s. *Educational Evaluation and Policy Analysis*, *29*(3), 155–168. https://doi.org/10.3102/0162373707305586

Bacolod, M. P. (2007). Do alternative opportunities matter? The role of female labor markets in the decline of teacher quality. *The Review of Economics and Statistics*, *89*(4), 737–751.

Balter, D., & Duncombe, W. D. (2008). Recruiting Highly Qualified Teachers: Do District Recruitment Practices Matter? *Public Finance Review*, *36*(1), 33–62. https://doi.org/10.1177/1091142106293949

Belfield, C. R., & Heywood, J. S. (2008). Performance pay for teachers: Determinants and consequences. *Economics of Education Review*, *27*(3), 243–252. https://doi.org/10.1016/j.econedurev.2008.01.002

Binder, A. J., Davis, D. B., & Bloom, N. (2016). Career Funneling: How Elite Students Learn to Define and Desire Prestigious Jobs. *Sociology of Education*, *89*(1), 20–39. https://doi.org/10.1177/0038040715610883

Blustein, D. L. (2006). *The psychology of working: a new perspective for career development, counseling, and public policy*. Mahwah, N.J: Lawrence Erlbaum Publishers.

Blustein, D. L., Kenna, A. C., Gill, N., & DeVoy, J. E. (2008). The psychology of working: A new framework for counseling practice and public policy. *The Career Development Quarterly*, *56*(4), 294–308.

BMW M Models - BMW USA. (2017). Retrieved November 01, 2017, from https://www.bmwusa.com/vehicles/m.html

Bowlby, J. (1980). *Attachment and loss*. New York: Basic Books.

Brunetti, G. J. (2001). Why do they teach? A study of job satisfaction among long-term high school teachers. *Teacher Education Quarterly*, *28*(3), 49–74.

Burns, M. (2013). Obama Education Secretary Duncan: Teachers should start at $70K per year | MLive.com. Retrieved October 22, 2017, from http://www.mlive.com/news/detroit/index.ssf/2013/05/obama_education_secretary_dunc.html

Cain-Caston, Marlene. (1999). A Survey of Opinions of North Carolina School Administrators Regarding Factors Considered Most Important in Hiring Teachers for their First Teaching Position. *Journal of Instructional Psychology*, *26*(2), 69–73.

Chetty, R., Friedman, J. N., & Rockoff, J. E. (2014). Measuring the Impacts of Teachers II: Teacher Value-Added and Student Outcomes in Adulthood. *American Economic Review*, *104*(9), 2633–2679. https://doi.org/10.1257/aer.104.9.2633

Chingos, M. M., & West, M. R. (2012). Do more effective teachers earn more outside the classroom? *Education*, *7*(1), 8–43.

Clotfelter, C., Glennie, E., Ladd, H., & Vigdor, J. (2008). Would higher salaries keep teachers in high-poverty schools? Evidence from a policy intervention in North Carolina. *Journal of Public Economics*, *92*(5–6), 1352–1370. https://doi.org/10.1016/j.jpubeco.2007.07.003

Cochran-Smith, M. (2004). Stayers, Leavers, Lovers, and Dreamers: Insights about Teacher Retention. *Journal of Teacher Education*, *55*(5), 387–392. https://doi.org/10.1177/0022487104270188

Cooper, J. M., & Alvarado, A. (2006). *Preparation, recruitment, and retention of teachers*. International Institute for Educational Planning. Retrieved from https://smec.curtin.edu.au/local/documents/5_Cooper_web_151206.pdf

Corcoran, Sean P., Evans, W., & Schwab, R. (2004). Changing Labor-Market Opportunities for Women and the Quality of Teachers, 1957-2000. *AEA Papers and Proceedings*, *94*(2), 230–235.

Correa, J. A., Parro, F., & Reyes, L. (2015). Self-selection in the market of teachers. *Applied Economics*, *47*(13), 1331–1349. https://doi.org/10.1080/00036846.2014.995365

Creswell, J. W., & Creswell, J. W. (2007). *Qualitative inquiry & research design: choosing among five approaches* (2nd ed). Thousand Oaks: Sage Publications.

Duncan, G. J., & Murnane, R. J. (2011). *Whither opportunity?: Rising inequality, schools, and children's life chances*. Russell Sage Foundation.

Duschl, R. A., Schweingruber, H. A., Shouse, A. W., National Research Council (U.S.), National Research Council (U.S.), & National Research Council (U.S.) (Eds.). (2007). *Taking science to school: learning and teaching science in grades K-8*. Washington, D.C: National Academies Press.

Fajet, W., Bello, M., Leftwich, S. A., Mesler, J. L., & Shaver, A. N. (2005). Pre-service teachers' perceptions in beginning education classes. *Teaching and Teacher Education*, *21*(6), 717–727. https://doi.org/10.1016/j.tate.2005.05.002

Feng, L. (2009). Opportunity Wages, Classroom Characteristics, and Teacher Mobility. *Southern Economic Journal*, *75*(4), 1165–1190.

Gilpin, G. A. (2011). Reevaluating the effect of non-teaching wages on teacher attrition. *Economics of Education Review*, *30*(4), 598–616. https://doi.org/10.1016/j.econedurev.2011.03.003

Gilpin, G. A. (2012). Teacher salaries and teacher aptitude: An analysis using quantile regressions. *Economics of Education Review*, *31*(3), 15–29. https://doi.org/10.1016/j.econedurev.2012.01.003

Gilpin, G., & Kaganovich, M. (2012). The quantity and quality of teachers: Dynamics of the trade-off. *Journal of Public Economics*, *96*(3–4), 417–429. https://doi.org/10.1016/j.jpubeco.2011.10.003

Goldhaber, D., Gross, B., & Player, D. (2007). Are Public Schools Really Losing Their Best? Assessing the Career Transitions of Teachers and Their Implications for the Quality of the Teacher Workforce. Working Paper 12. *National Center for Analysis of Longitudinal Data in Education Research*. Retrieved from http://eric.ed.gov/?id=ED509666

Goldhaber, D., & Player, D. (2005). What Different Benchmarks Suggest About How Financially Attractive It Is to Teach in Public Schools. *Journal of Education Finance*, *30*(3), 211–230.

Greene, J. P., & Winters, M. A. (2007). An evaluation of the effect of DC's voucher program on public school achievement and racial integration after one year. *Journal of Catholic Education*, *11*(1).

Hanushek, E. (2004). *Some Simple Analytics of School Quality* (No. w10229). Cambridge, MA: National Bureau of Economic Research. https://doi.org/10.3386/w10229

Hanushek, E. A. (2007). The single salary schedule and other issues of teacher pay. *Peabody Journal of Education*, *82*(4), 574–586.

Hanushek, E. A. (2011a). The economic value of higher teacher quality. *Economics of Education Review*, *30*(3), 466–479. https://doi.org/10.1016/j.econedurev.2010.12.006

Hanushek, E. A. (2011b). Valuing teachers. *Education next*, *11*(3). Retrieved from http://search.proquest.com/openview/c16a9f3cdf72948053d30485f1d38e14/1?pq-origsite=gscholar&cbl=1766362

Hanushek, E. A., Kain, J. F., & Rivkin, S. G. (2004). The revolving door: A path-breaking study of teachers in Texas reveals that working conditions matter more than salary. *Education Next*, *4*(1), 76–83.

Hanushek, E. A., Piopiunik, M., & Wiederhold, S. (2014). The Value of Smarter Teachers: International Evidence on Teacher Cognitive Skills and Student Performance. Program on Education Policy and Governance Working Papers Series. PEPG 14-06. *Program on Education Policy and Governance*. Retrieved from http://eric.ed.gov/?id=ED562624

Hanushek, E. A., & Rivkin, S. G. (2006). Chapter 18 Teacher Quality. In *Handbook of the Economics of Education* (Vol. 2, pp. 1051–1078). Elsevier. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S1574069206020186

Hanushek, E. A., & Rivkin, S. G. (2007). Pay, working conditions, and teacher quality. *The Future of Children*, 69–86.

Hanushek, E. A., & Woessmann, L. (2011). Overview of the symposium on performance pay for teachers. *Economics of Education Review*, *30*(3), 391–393. https://doi.org/10.1016/j.econedurev.2010.12.005

Harris, D. N., & Sass, T. R. (2011). Teacher training, teacher quality and student achievement. *Journal of Public Economics*, *95*(7–8), 798–812. https://doi.org/10.1016/j.jpubeco.2010.11.009

Hendricks, M. D. (2014). Does it pay to pay teachers more? Evidence from Texas. *Journal of Public Economics*, *109*, 50–63. https://doi.org/10.1016/j.jpubeco.2013.11.001

Hendricks, M. D. (2015). Towards an optimal teacher salary schedule: Designing base salary to attract and retain effective teachers. *Economics of Education Review*, *47*, 143–167. https://doi.org/10.1016/j.econedurev.2015.05.008

Henry, G. T., Bastian, K. C., & Smith, A. A. (2012). Scholarships to Recruit the "Best and Brightest" Into Teaching. *Educational Researcher*, *41*(3), 83–92. https://doi.org/10.3102/0013189X12437202

Henry, G. T., Purtell, K. M., Bastian, K. C., Fortner, C. K., Thompson, C. L., Campbell, S. L., & Patterson, K. M. (2014). The effects of teacher entry portals on student achievement. *Journal of Teacher Education*, *65*(1), 7–23.

Hoxby, C. M., & Leigh, A. (2004). Pulled away or pushed out? Explaining the decline of teacher aptitude in the United States. *The American Economic Review*, *94*(2), 236–240.

Imazeki, J. (2005). Achieving Educational Adequacy through School Finance Reform. CPRE Research Report Series. Retrieved from http://eric.ed.gov/?id=ED465202

Ingersoll, R. M. (2012). Beginning Teacher Induction What the Data Tell Us. *Phi Delta Kappan*, *93*(8), 47–51. https://doi.org/10.1177/003172171209300811

Ingersoll, R. M., & May, H. (2012). The Magnitude, Destinations, and Determinants of Mathematics and Science Teacher Turnover. *Educational Evaluation and Policy Analysis*, *34*(4), 435–464. https://doi.org/10.3102/0162373712454326

Jordan, J. V., & Stone Center for Developmental Services and Studies (Eds.). (1991). *Women's growth in connection: writings from the Stone Center*. New York: Guilford Press.

Kane, T. J., Rockoff, J. E., & Staiger, D. O. (2008). What does certification tell us about teacher effectiveness? Evidence from New York City. *Economics of Education Review*, *27*(6), 615–631. https://doi.org/10.1016/j.econedurev.2007.05.005

Kelly, S., & Northrop, L. (2015). Early Career Outcomes for the “Best and the Brightest”: Selectivity, Satisfaction, and Attrition in the Beginning Teacher Longitudinal Survey. *American Educational Research Journal*, *52*(4), 624–656. https://doi.org/10.3102/0002831215587352

Kershaw, J. A., & McKean, R. N. (1962). Teacher shortages and salary schedules [by] Joseph A. Kershaw [and] Roland N. McKean. [Product Page]. Retrieved October 22, 2017, from https://www.rand.org/pubs/research_memoranda/RM3009.html

Kerstetter, J. (2016, August 23). The 2016 EdNext Poll – including 10-year trends in public opinion. *Education Next*. Retrieved from http://educationnext.org/the-2016-ednext-poll-including-10-year-trends-in-public-opinion/

Kihn, P., & Miller, M. (2010, October 10). Why aren’t our teachers the best and the brightest? *The Washington Post*, p. 4.

Kolbe, T., & Strunk, K. O. (2012). Economic Incentives as a Strategy for Responding to Teacher Staffing Problems: A Typology of Policies and Practices. *Educational Administration Quarterly*, *48*(5), 779–813. https://doi.org/10.1177/0013161X12441011

Kyriacou, C., & Coulthard, M. (2000). Undergraduates’ Views of Teaching as a Career Choice. *Journal of Education for Teaching*, *26*(2), 117–126. https://doi.org/10.1080/02607470050127036

Ladd, H. F. (2007). Teacher Labor Markets in Developed Countries. *The Future of Children*, *17*(1), 201–217. https://doi.org/10.1353/foc.2007.0006

Leigh, A. (2012). Teacher pay and teacher aptitude. *Economics of Education Review*, *31*(3), 41–53. https://doi.org/10.1016/j.econedurev.2012.02.001

Lin, E., Shi, Q., Wang, J., Zhang, S., & Hui, L. (2012). Initial motivations for teaching: comparison between preservice teachers in the United States and China. *Asia-Pacific Journal of Teacher Education*, *40*(3), 227–248. https://doi.org/10.1080/1359866X.2012.700047

Liu, E., Kardos, S. M., Kauffman, D., Peske, H. G., & Johnson, S. M. (2000). Barely breaking even: Incentives, rewards, and the high costs of choosing to teach. *Cambridge: Harvard Graduate School of Education*. Retrieved from http://projectngt.gse.harvard.edu/files/gse-projectngt/files/barely_breaking_even_0700.pdf

Loeb, S., Miller, L. C., & Wyckoff, J. (2015). Performance Screens for School Improvement The Case of Teacher Tenure Reform in New York City. *Educational Researcher*, *44*(4), 199–212.

Long, S. (2007). The Cost of Teacher Turnover in Math and Science. *Science Teacher*, *74*(3), 10–10.

Mason, P. M., Fabritius, M., & Johnson, C. K. (2015). Wage Differentials for Pre-College Teachers to Solve Shortages and Quality Issues? *Journal of Economics and Economic Education Research*, *16*(1), 107.

Merriam, S. B. (2002). *Qualitative research in practice: examples for discussion and analysis* (1st ed). San Francisco: Jossey-Bass.

Mincu, M. E. (2015). Teacher quality and school improvement: what is the role of research? *Oxford Review of Education*, *41*(2), 253–269. https://doi.org/10.1080/03054985.2015.1023013

Murnane, R. J., & Olsen, R. J. (1989). The Effect of Salaries and Opportunity Costs on Duration in Teaching: Evidence from Michigan. *The Review of Economics and Statistics*, *71*(2), 347–352. https://doi.org/10.2307/1926983

Murnane, R., Singer, J., & Willett, J. (1989). The influences of salaries and “opportunity costs” on teachers’ career choices: Evidence from North Carolina. *Harvard Educational Review*, *59*(3), 325–347.

NACE Research Reports. (n.d.). Retrieved June 14, 2017, from http://www.naceweb.org/research/reports/

Nagler, M., Piopiunik, M., & West, M. R. (2015). *Weak markets, strong teachers: Recession at career start and teacher effectiveness*. National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w21393

National Center for Education Statistics (NCES) Home Page, part of the U.S. Department of Education. (n.d.). Retrieved June 14, 2017, from https://nces.ed.gov/

Occupational Outlook Handbook: U.S. Bureau of Labor Statistics.. Retrieved June 23, 2017, from https://stats.bls.gov/ooh/home.htm

Ondrich, J., Pas, E., & Yinger, J. (2008). The Determinants of Teacher Attrition in Upstate New York. *Public Finance Review*, *36*(1), 112–144. https://doi.org/10.1177/1091142106294716

Pearce-Moses, R. (2005). *A glossary of archival and records terminology*. Chicago: Society of American Archivists.

Perez, T., Cromley, J. G., & Kaplan, A. (2014). The role of identity development, values, and costs in college STEM retention. *Journal of Educational Psychology*, *106*(1), 315–329. https://doi.org/10.1037/a0034027

Phillips, O. (2015). Revolving Door Of Teachers Costs Schools Billions Every Year. Retrieved October 22, 2017, from http://www.npr.org/sections/ed/2015/03/30/395322012/the-hidden-costs-of-teacher-turnover

Podgursky, M. J., & Springer, M. G. (2007). Teacher performance pay: A review. *Journal of Policy Analysis and Management*, *26*(4), 909–950. https://doi.org/10.1002/pam.20292

Podgursky, M., & Tongrut, R. (2006). (Mis-)Measuring the Relative Pay of Public School Teachers. *Education Finance and Policy*, *1*(4), 425–440. https://doi.org/10.1162/edfp.2006.1.4.425

Quick, J. C., Tetrick, L. E., & American Psychological Association (Eds.). (2011). *Handbook of occupational health psychology* (2nd ed). Washington, DC: American Psychological Association.

Rampel, K. (2010, September 20). The Recession Has (Officially) Ended - The New York Times. Retrieved October 22, 2017, from https://economix.blogs.nytimes.com/2010/09/20/the-recession-has-officially-ended/

Ray, M. A., Anderson, D. A., Krugman, P. R., & Worth Publishers. (2011). *Krugman's economics for AP**. New York: Worth Publishers.

Rickman, D. S., Wang, H., & Winters, J. V. (2017). RELATIVE TEACHER SALARIES AND THE DECISION TO TEACH. *Contemporary Economic Policy*, *35*(3), 542–550. https://doi.org/10.1111/coep.12195

Riggs, L. (2013). Why do teachers quit. *The Atlantic*, *10*, 3–5.

Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica*, *73*(2), 417–458.

Rockoff, J. E. (2004). The impact of individual teachers on student achievement: Evidence from panel data. *The American Economic Review*, *94*(2), 247–252.

Rothstein, J. (2015). Teacher Quality Policy When Supply Matters. *American Economic Review*, *105*(1), 100–130. https://doi.org/10.1257/aer.20121242

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: basic psychological needs in motivation, development, and wellness*. New York: Guilford Press.

Shavelson, R. J., Towne, L., National Research Council (U.S.), & Committee on Scientific Principles for Education Research. (2002). *Scientific research in education*. Washington, DC: National Academy Press. Retrieved from http://public.eblib.com/choice/publicfullrecord.aspx?p=3375187

Shuls, J., & Maranto, R. (2014). Show Them the Mission: A Comparison of Teacher Recruitment Incentives in High Need Communities: Teacher Recruitment Incentives in High Need Communities. *Social Science Quarterly*, *95*(1), 239–252. https://doi.org/10.1111/ssqu.12011

Silber, J. (1998). Good Teachers Deserve A Tax Break. Retrieved October 22, 2017, from http://www.wsj.com/articles/SB907401579961539500

Smith, E. (2008). Raising standards in American schools? Problems with improving teacher quality. *Teaching and Teacher Education*, *24*(3), 610–622. https://doi.org/10.1016/j.tate.2007.09.013

Sojourner, A. J., Mykerezi, E., & West, K. L. (2014). Teacher Pay Reform and Productivity: Panel Data Evidence from Adoptions of Q-Comp in Minnesota. *Journal of Human Resources*, *49*(4), 945–981. https://doi.org/10.3368/jhr.49.4.945

Staklis, S., & Henke, R. (2013). Who Considers Teaching and Who Teaches? First-Time 2007-08 Bachelor's Degree Recipients by Teaching Status 1 Year after Graduation. Stats in Brief. NCES 2014-002. *National Center for Education Statistics*. Retrieved from http://eric.ed.gov/?id=ED544454

Steele, J. L., Murnane, R. J., & Willett, J. B. (2010). Do financial incentives help low-performing schools attract and keep academically talented teachers? Evidence from California. *Journal of Policy Analysis and Management*, *29*(3), 451–478. https://doi.org/10.1002/pam.20505

Strauss, Valerie. (2014, March 25). Why teacher's salaries should be doubled - now [Newspaper Website]. Retrieved November 30, 2016, from

Taylor, L. L. (2008). Comparing teacher salaries: Insights from the U.S. census. *Economics of Education Review*, *27*(1), 48–57. https://doi.org/10.1016/j.econedurev.2006.06.002

Thomson, M. M., Turner, J. E., & Nietfeld, J. L. (2012). A typological approach to investigate the teaching career decision: Motivations and beliefs about teaching of prospective teacher candidates. *Teaching and Teacher Education*, *28*(3), 324–335. https://doi.org/10.1016/j.tate.2011.10.007

Walsh, K. (2013). 21st-century teacher education. *Education Next*, *13*(3). Retrieved from http://search.proquest.com/openview/14d9ce81070d171c1e9dbe98e476e0b2/1?pq-origsite=gscholar&cbl=1766362

Walsh, P. (2014). When Unified Teacher Pay Scales Meet Differential Alternative Returns. *Education Finance and Policy*, *9*(3), 304–333. https://doi.org/10.1162/EDFP_a_00135

Watt, H. M. G., & Richardson, P. W. (2008). Motivations, perceptions, and aspirations concerning teaching as a career for different types of beginning teachers. *Learning and Instruction*, *18*(5), 408–428. https://doi.org/10.1016/j.learninstruc.2008.06.002

Watt, H. M. G., Richardson, P. W., Klusmann, U., Kunter, M., Beyer, B., Trautwein, U., & Baumert, J. (2012). Motivations for choosing teaching as a career: An international comparison using the FIT-Choice scale. *Teaching and Teacher Education*, *28*(6), 791–805. https://doi.org/10.1016/j.tate.2012.03.003

Watt, H. M., & Richardson, P. W. (2007). Motivational factors influencing teaching as a career choice: Development and validation of the FIT-Choice Scale. *The Journal of Experimental Education*, *75*(3), 167–202.

Wilson, S. M. (2011). How Can We Improve Teacher Quality? Recruit the Right Candidates, Retain Teachers Who Do Well, and Ensure Strong Preparation, Good Working Conditions, and Quality Professional Development. *Phi Delta Kappan*, *93*(2), 64.

Wilson, S. M., Floden, R. E., Dilworth, M. E., Education Commission of the States, ERIC Clearinghouse on Teaching and Teacher Education, & American Association of Colleges for Teacher Education. (2003). *Creating effective teachers: concise answers for hard questions*. Washington, D.C.: AAECT Publications.

Wolfson, M. (1948, July 6). Low teacher salaries. *New York Times*, p. 22.

Yeh, S. S. (2011). The cost-effectiveness of raising teacher quality. *Educational Research Review*, *4*(3), 220–232. https://doi.org/10.1016/j.edurev.2008.06.002

Appendix A

Interview One

Q: So, how did you first become interested in becoming a teacher and what was your experience in choosing teaching as a career?

A: I wasn’t ever going to be a teacher, but I wasn’t against it I wasn’t for it, when I graduated, a couple weeks after I graduated I got a call from a private school, I lived in Illinois, and they were desperately looking for teachers, so when I look back I think that was the seed, and I thought oh that could be fun, so then I moved back down here and I was doing medical sales, did not like that as a career choice, so I was looking for a healthier fit in terms of a career choice, so I had thought initially I could try teaching and it never hurts to have a certificate. It would never hurt me to try. So I did an alternative certification program, to try teaching. And that was 16 years ago

Q: Wow - and it worked out?

A: It worked out!

Q: What was your undergraduate degree in?

A: Microbiology with a minor in chemistry.

Q: Which do you prefer, bio or chem?

A: To be honest it was equal and when I look back as an undergraduate, it’s easy to look back and say that because of the professor I couldn’t learn it as well, but I didn't have as well defined study skills, and it would have made me more successful cause I actually think chemistry is very exciting. So probably interest I like them both equally. Just worked out that way.

Q: What has kept you in the classroom as a science teacher? Why do you continue to work in the profession?

A: There is not a clear, I, to be honest, it has taken a long time to say I like teaching and that sounds silly to say out loud because it was never a career choice, I was never one of those, I have to be a teacher, I love children, so I, it's a fun challenge, every day is different. I get to push myself personally. I get to help people get better. I don't know I feel like I am good at it, not in a bagful (sic) way, I enjoy working with the kids, and I enjoy making connections, and while there is one or two that maybe I don't, because that is just human nature, I am good at making those relationships, and I see them, like a week ago I got an email from somebody who graduated three years ago, 'So and So, I am doing a biology major and I just wanted you to know, it was because of your class,' like that was a key defining, now that's not my goal to make everyone be a science major but it is to give them options, and possibilities and I think that is a cool thing that I can facilitate that process.

Q: So, why was teaching originally not an option for you?

A: It wasn't an option or non-option it just didn't, and the strange thing is the college I went to, the top career, it was known for law enforcement and education. It just wasn't, and I think possibly the people I knew in education were elementary and elementary is very different and that's not me and I just never made that connection. But probably always had, like I remember having all the study sessions, and I would explain things to people and they would get better grades then I would, and it never made sense to me, but I think I just naturally had that ability.

Q: So, have you ever considered leaving the classroom during your years as a teacher? What were those thoughts and what made you eventually change your mind and stay in the classroom?

A: Yes. I couldn't even tell you when I stopped, but I could tell you my first four years for sure, I looked every spring at working outside of education. Because it is so much harder than anyone ever tells you, because it is so much more work, and it’s a challenge, and those are things you don’t see, and I never needed recognition from other people, but what the frustration being, is they just automatically assume it is a 7-3 job and it’s not, not to do an effective job, so I know for the first handful of years, what a shock to the system that was, and that I would just look, at what possibilities and options there were.

Q: So what then, kept you in the classroom?

A: I think just my own personal, I made a commitment to it and initially, and in those early days, definitely and then because of the three schools I have worked in, at the time very low socio-economic, those types of relationships were completely different. And what was hard was no matter how hard you worked you don't get to see the results of that, in terms of pure data. With people you can see the results in a person and then it got to a point where I actually needed to determine was I effective in this career choice or not and I had to change school to see that, because I still to this day I firmly believe that you shouldn’t be in the classroom with kids if you aren’t willing to do what it takes to help them learn. And it was a promise I always made myself that if I ever got to that place to email those teachers that don’t belong in the classroom that don’t like people or children, that I would leave. And I knew I didn’t ever have that, never once, even in those times early where I looked, I never was that person. But I also don’t think you should be in the classroom if you can’t teach, and there is nothing wrong with not being able to unless you are there negatively affecting 150 kids daily.

Q: Did you have any role models or mentors that influenced your becoming a teacher or the way you work as a teacher? What can you say about their impact on your career?

A: Becoming a teacher no, but when I was a teacher, when I look back at things that are very core to my foundation now, I don’t necessarily view as mentors but they were leaders, but they had a very positive influence in me now, and I had very positive mentors that were. There was a district coordinator, who then became principal, she really pushed hard and introduced me to a lot of PD Experience and looking back now are fundamental aspects of how I run my classroom, so it goes back to those experiences. And I have to credit her with that because I wouldn’t have had those opportunities at other places. Some of her leadership skills I would, at this point of my career I would never work for, but in terms of a mentor but in terms of a leader I would never want to be whether it is in my classroom or otherwise. But then I have had others who were very positive in pushing me to be better. I remember the first year I ever taught AP, and I didn’t even know how to be a teacher at that point, but having conversations and being very open and honest and pushing to be a little bit better, and that I still see, I still picture them saying 'look its 16 years and I am still do enjoy fundamentally my job, so even though I changed schools, I went to a different school for two years, I didn't have those types of relationships again and I have been here for 10 and I have had influential mentors but not as much, like I can see the core foundation of who I am as a teacher from those two very specific people. The one guiding, and giving lots of meaningful advice, not necessarily answers, and the other one Sergeant Major, but very clear guidelines and perspective.

Q: How important is the subject you teach to you being a teacher? Is it your passion for science that motivates you to teach or your passion for working with young people that motivates you?

A: Yeah, probably a combination. I love what I teach though, but just the level that I teach it isn't as important to me. There were even times over the summer where I thought just make me a full time freshman level teacher. Because in terms of the subject I don't care if it is not your passion, because everybody at some point in their life is going to need some terms we teach kids because it is a life skill. And so it's kind of fun. and it's kind of fun to get a kid the first day of school who says you know what, I am not good at science. You know what, its rubbish - of course you are. And getting them to see that they can do difficult things because there is this association that science is hard. I mean parents tell you at open house, you know what I hated dissecting a frog, we don't do that! It almost becomes a generational opinion toward the subject. I grew overseas where girls did Biology and boys did Physics and Chemistry it's kind of the same thing but not as obvious. Kids need to have some basics. It is awesome if they go into the field because we need new energy new minds, people like our kids who don't know what the word no - to try new things because we need solutions to problems and medically and health wise we need a lot of solutions, we need fresh brains for, they only ever contemplate those options if there is a spark now. Content may be driving; I like high school age definitely.

The kid part is hard because I love the kid part, and I never necessarily contemplated it because I don’t have the skill set at this level to teach other subjects.

Q: So what have been some of your most rewarding experiences as a teacher?

A: There could be lots. And I suppose they are all associated with individual stories. I was thinking of one student this weekend who is a senior in college now, he visits me every six months or once a year. But as a freshman, but I remember one time, always did his homework, onetime he didn't have his homework done, and I said "Tyler, what is this about?" And I even in an uglier tone than that and this big boy even at 14 started crying, his brother tried to commit suicide the night before. And we got interventions in place and we got him through that, and by we, I mean the counselors and me jointly and he took my class again as a senior, but even through high school, he would come visit me. And now I still get those mental, and I get the whole family that I see that he is doing good and doing well and on a good track. He is going to be business, probably even a business lawyer, he is not a science person. So probably I could list a handful of kids who are like that. So I think that those are it."

Q: On the opposite side, what experiences have been most discouraging or most depressing about being a teacher?

A: There are different capacities about that, in the same respect there are kids that, that you lose. And you don’t know whatever happened to them. And there are kids there through their career that are there for a short time and there are dreadful things they are either inflicting on themselves or whatever. And we have some control, but not really any as teachers. So from the opposite spectrum then, outside of the kid arena, um, some of the worst times as a teacher have been relationships with other adults. And possibly very communication based, you know how you can look back, with different perspective and I can look back and see that I was an instigator and caused other adults to not have a good experience and you can't go back and fix that but now in my position when I work with adults, I try to guide people to not make errors in that way. Because it is easy to fall into a trap where you think yours is the only good way. But you don't have that thought process at the time. OR your told by so many people that you are doing such a great job that then nobody else could possibly do a good job. And once again you don't have that specific thought process at the time, that's not your leading motivator but there are times where I was on a team and I was not the best team mate and you look back on communication not knowing how to deal with that appropriately because in education we don't work alone and kids are better when they have a group of adults, whether they have the same subject or not, are on the same page. So negative experiences, probably the most negative have been adult's interactions.

Q: Are there any other comments or observations you would like to make about your work?

A: I just think it is important. I have had opportunities to go to national conferences over the last couple of years and I joke with kids, "Oh Physics" it just you know is the game you play. But you know most of the good up and coming careers are science based, or that they are, my biology science or not, it doesn't matter. There are so many that are fundamentally ground in that, a conversation I had with a teacher a couple of years ago, he wanted to be a doctor, he wasn't in medical school yet, he hated teaching, when you come every day and have a bad day what you are choosing for kids is that they will never consider a career in any medical field because of their experience in this class, because I have noticed over time it is human nature, especially with kids, is that they will seek out things that they are good at or comfortable at and that is very teacher based. And we are very fortunately or not, powerful position to have influence over our students lives in terms of career choices and abilities and their perceptions of their own abilities. And it's not easy, but we have to teach them how to do hard things. And sometimes science can be hard, but that's not just in my classroom.

Interview Two

Q: How did you first become interested in becoming a teacher and what was your experience in choosing teaching as a career?

A: I taught in college as a teaching assistant in labs for graduate school, and I enjoyed that very much. But I knew the salary was not very high so I decided to go and get my masters and go into industry and then I had kids. And once I had kids, I saw the impact that their teachers had on them, and wanted to see if I could do the same thing.

Q: What has kept you in the classroom?

A: The Kids!

Q3: Did you expect that going into it?

A: Not at all, I thought I knew it would be interesting, and I was really hoping to be able to share my love of science with those students. But the relationships that I am building with those kids is what keeps you in the classroom?

Q: And so I am guessing that is why you continue to work in the profession.

A: Oh yeah. It's not about the money. It's not.

Q: Have you ever considered leaving the classroom during your years as a teacher?

A: No.

Q: Do you think part of that is because, if it was financial stability issue, would you have to consider that?

A: Right now, I am financially ok, because my husband has an industry job, if it came to that, if he lost his job, I would see what I would need to do. I would rather not leave the classroom - I mean I love my job I feel that it is my calling - and I had no idea it would be that way.

Q: Talk to me a little bit about whether you had any role models or mentors, that influenced you into becoming a teacher or once you became a teacher, how did those role models or mentors shape you into who you are?

A: I really just kind of watched some of the teachers on campus, that had those relationships with the kids, those teachers that, the kids loved and wanted to work for. And wanted to spend time with and just kind of watched some of those, and tried to emulate them a little bit as far as the relationship goes, because I think that is where the whole crux of education lies is within the relationships you can build with your kids.

Q: When it comes to having a degree in Chemistry, was there ever a thought of not teaching high school or teaching a younger grade?

A: No. Never.

Q: So talk to me a little bit about the passion for your subject and how that ties into why you teach.

A: That came back to my high school teacher, my high school chemistry teacher, completely inspired me into learning more about chemistry. And so that is why I decided what to get my degree in, and because I am so fascinated by it, I wanted to share that a little bit. And so, I can't do that to the degree that I want to with any grade younger than high school. It's my jam, it's my think, it's what I like.

Q: So do you think it is more your passion for the subject that you teach or the passion for the kids that makes you an excellent teacher.

A: I think it started as a passion for my subject and I used to teach Chemistry - but now I teach Chemistry to students - I teach students now. And so, it is really all about the kids and I don't care if I am teaching Chemistry, I'd teach Biology, I'd teach Physics. But I am not leaving teaching. And so, hanging out with those kids, that is the best part of my day.

Q: What has been your most rewarding experience as a teacher, or your most rewarding experiences, and also think about conversely, what is the most depressing or discouraging about being a teacher?

A: The most inspiring is probably being chosen as the most inspirational teacher female teacher twice on our campus because that tells me that I am actually doing what I am setting out to do, and that is build those relationships with the kids and let them know that I care and I do want to inspire them. The hardest part is probably trying to reach those kids that don't want to be reached, and whether it is PreAP or not, they are sitting in PreAP because their parents wanted them to take PreAP, and they are just sitting there, the hardest part, the most depressing part, is when I don't get to reach those kids. When I don't get to inspire them - or even interest them a little bit - in that thing that I love so much. That is probably the hardest, other than paper work and extra classroom, outside of the classroom stuff that we have to do. Some of the accommodations that we have to fulfill, it's not really depressing but its, challenging I guess. Depressing is not meeting the kid's needs.

Q: What other comments or observations would you like to make about your work as a science teacher?

A: When, ok, so, when students go onto major in something because you lit that spark, is pretty exciting to watch, a student I had for three years in a row got a full ride to MIT, to study chemistry. I had something to do with that - and he keeps communicating with me and emailing me and telling me how his first year is going and its pretty exciting.

Q: Why do we struggle to find good science teachers?

A: I mean, I could make three times what I am making now if I was in industry, maybe four with my masters, so it can't be about the pay, and that is hard to say, because you still have to pay the bills, you still have to make your mortgage, you still have to send your kids off to college, and sending your kids off to college on a teacher's salary, that's a tight budget. That's tight.

Q: Anything else you want to add?

A: Shouldn't be about passion? If you're not passionate about education, get the heck out. There is no room for you on the bus. If you're not in it for the kids, if this is a post-industry job to kill some time and you're not passionate about it.

Q: Do you think that passion can be grown?

A: Oh I think it can be grown - because I had no idea how much I was going to love this career. None at all, I thought I would go in and I would blow stuff up and teach them cool things, but I didn't understand how much the kids would mean to me - and they do.

Interview Three

Q: How did you first become interested in becoming a teacher and what was your experience in choosing teaching as a career?

A: I probably first became interested in about 6th grade, I always really liked school and I was always really good at school, and for the most part I really liked my teachers too, so it seemed like almost a fun career, but I really didn't do anything with it, you know in high school I was definitely wanting to go to medical school for a medical type career, and then when I started college, I started a biology degree, and then the college of natural science also had a teaching program where you could get your biology degree and teaching credentials at the same time, so I had started that just for thinking that it might be something I want to do, I didn't actually complete that teaching program in college, my plans changed a little bit, I wanted to study abroad and plans didn't fit with that. So I didn't finish that but it was still sort of on my mind, and then as I got toward the end of my bachelor degree and I realized what I thought I had wanted to do as a career, I didn't actually want to do as a career, and I thought you know what, I have always thought about this teacher thing and it is something I always thought I could do, so then I started the alternative certification to actually get that certification.

Q: So, what has kept you in the classroom as a science teacher and why do you continue to work in the profession?

A: Um, I think it’s a combination. I really like the science part of it, I really like Biology, so I know I need to do something Biology related, and even though there are some students, that come back the next year that say how much they liked having me as a teacher, so sort of having that feedback from those kids that I what I am doing is important to them keeps me doing it over and over again. As far as the masters, I wanted more opportunities down the road to do something different but in the same realm.

Q: Have you ever considered leaving the classroom during your years as a teacher, if so what were those thoughts?

A: Um, I have never seriously considered it as far as applying anywhere or anything like that, I have occasionally been like you know what, maybe I should look into something else, I know these people who are in medical school right now, or this person who is doing this, and you know I wonder, where is my career going to go? Um, but never seriously considered it, just sort of you know thought, are there options I could pursue and at this point there aren't too many out there without additional schooling needed, which I am not gun-ho about at the moment.

Q: Any thoughts about teaching as a long-term career choice? What do you think opportunities down the road could look like?

A: I would be really surprised if I completely left education. Now I could see changing what it looks like down the road, maybe not always looking like a classroom teacher, but I could see still in education but in a different role.

Q: Talk to me about role models or mentors that influenced becoming a teacher or the way you work currently as a teacher.

A: When I was in high school I had a biology teacher who I thought was super great, and being in a small magnet school setting for science, I had him for multiple subjects several years in a row. I feel like he made a difference for me and I saw him as his job wasn't just to stand there and teach me stuff, he cares and he wants to help me, or I can come after school and he will help me with my science fair project, so it sort of seems that a little bit more than just a typical teacher teaching information, it was more than information.

Q: How important is the subject you teach to you being a teacher? Is it your passion for science that motivates you to teach or your passion for young people that motivates you to teach?

A: Definitely when I started it was the passion for science. So I love teaching biology and there is not another subject I would want to teach, so even if it was another science like chemistry or physics, that would not go well, so I definitely love the biology part of it, and as I am in it longer and longer, the working with young people has gained importance, where initially I was like, I really love Biology and it’s going to be great and I love Biology and we're going to teach Biology to young people where not it has shifted to, I am really glad I get to teach biology to these young people and help them and blah, blah, blah. I have seen a shift over the first few years in the classroom.

Q: What is your most rewarding experience as a teacher?

A: Two years ago, on the last day of school, I had a student write me a letter, and it was a letter about the things we had done all year long and the impact it had on her, and it was little things like saying hi to her when she walks in the classroom, but to have made her list as a way I had impacted her life that year.

Q: What experiences have been the most discouraging to being a teacher?

A: I have had some parents who have been a struggle, and sort of come from the mindset that I am out to get their kid, or I wasn't concerned about their kid, or I was trying to cause trouble, and that is discouraging, and you put all this time into it and in talking to the kid that was not my interpretation of what the kid thought, but certainly the parents interpretation, and that is hard to deal with because you think you are getting attacked, for doing what you are supposed to do and trying to help and all that.

Q: Are there any other comments or observations about your work as a science teacher?

A: Not that I know of.

Q: So you're glad you did it and glad you are still doing it?

A: Yes, I am glad I did it!

Interview Four

Q: What is your educational background and teaching certification in?

A: My certification is in general science, composite, 8-12, so I am certified to teach any science course. I am also certified as a principal but I am not using that certification, I also just recently got my ESL certificate – and that makes my department head happy. I have been teaching for 16 years, started in Louisiana, I have been in Texas about ten years. And my bachelor's degree is in Secondary science education with concentrations in Chemistry.

Q: How did you first become interested in teaching? How did you first think of teaching as a career?

A: I probably have a unique perspective in that. I thought I would be a teacher for a short amount of time. I was a chemical engineering major at LSU – Baton Rouge – and I was dead set, when I started college I started with a chemistry degree, and I changed my mind and went into the chemical engineering program. I wanted to be a chemical engineer – I was advised by my Uncle who was pretty high up at Halliburton I probably had a way to get in because of that, but my wife became pregnant when I was a student in chemical engineering and I decided to take a break from it, go to work, make money, we were about to have a child, and she was still a student at the time, so for economic reasons I left the chemical engineering program, and after our child was born, I decided I still wanted to go back into engineering or chemistry, but it would have taken a lot of money, a lot of time, in comparison to becoming a teacher. My wife completed her degree in teaching, so my goal at the time. She was still a student full time, for economic reasons I left the chemical engineering program. And then after our child was born, I decided I still wanted to go back into engineering or chemistry, but it was taking a lot of money, a lot of time, in comparison to becoming a teacher, so my goal then, at the time was to just teach, if I could get a fast track degree, I had already completed way more science than I needed, way more math than I needed, I had three levels of calculus by then, I had some engineering courses under my belt, I just needed the education classes, and then I could and then I became certified to teach science. In Louisiana, happened to have a very high demand for people that could teach physics, because hardly anybody was certified in physics, but they were teaching physics, out of certification, and they couldn’t get certified physics teachers. What I ended up doing, I thought I would just get my certification in teaching but I was really not interested in being a teacher long term. I just wanted to do it for just enough time so I could go back and finish my degree in chemistry or chemical engineering, I was a little more interested in chemical engineering, because if I did chemistry I would have to take it beyond the bachelor's degree and if I did chemical engineering, I could just get my bachelor's degree and start making money in industry. So that is how I got started. So I even told my supervising teacher, I was supervised by, when I was student teaching, and said I am probably only going to do this for three years or four years. I told them I really want to be an engineer but I need a way to make money but it was quicker to get the engineering courses knocked out, but of course things change.

Q: What keeps you in the classroom?

A: What keeps me in it is I have a really, I really love the process of teaching science, and I really enjoy the teaching of science, to be able to get paid to sit there and actually share your passion for something like that, I have a passion in the subject, and that is how I got started in and I went into teaching very subject oriented. It wasn't as student oriented as I should have, and I think that kids realize, that even at an early stage of teaching, when I didn't know hardly anything as far as pedagogy of teaching but I was so passionate for the subject that I think the kids realized that and it helped carry me through the first few years. And it kept me in it because I really enjoyed taking about science to kids. It kind of sparked an interest for them and took kids that may not, you know not really care about their education, you get a lot of those, kids who don't really care about school it’s not really their time yet, may never be their time to get into academics, but you know being able to you know maybe get some more, a little more passion about it, not just do science to get a grade and do their homework, the thing about science is you can really connect it to real life, especially physics. There is so much you can talk about in physics that is applicable to real life experiences. I guess that is what keeps me in it you know, I really enjoy that part of it.

Q: Have you ever thought about leaving the classroom?

A: Yes. Many times. There is just, I guess, going to the years as a man working in corporate world, before I became a teacher, I was actually fairly successful in business, I had a successful sales job in computers, where I sold in corporations, and I really learned a lot about corporate world and how to deal with people, how to represent a company, and I guess I had a draw for a long time of doing something different than teaching that would enhance some leadership opportunities for me. I guess what kept me, I was still trying to decide, "Do I want to leave teaching, do I want to go into science or go into engineering, it just didn't make sense to do a lateral change with all those years of education. So I decided if I am going to do something different than teaching, so either A I stay in teaching until I retire, which is not bad you know, but it's definitely does not completely fulfill the drive that I have. But there is something inside of me that wants to do something different and get into a leadership capacity - so it makes sense that I better do something where I can apply what I have already done, you know all these years of teaching, if I get a degree in being an administrator or my doctorate, then when I do decide or if I do decide to go into a leadership capacity at least if it is in education I will be using all the years I have taught I can apply that to a leadership position, especially being a leader of teachers, having those years of leading in teaching, makes sense then at the age of 40 something years old switching to engineering, or switching to chemistry, which is really not what I have been doing over the past 16 years. I just want to be able to have choices. Right now, I am very happy with my teaching load. I have a really good teaching schedule and I am at a crossroads, but I am wanting to get the credentials, so someday I can go for an assistant principal job or maybe I can teach at a college or something, I wanted to have those choices, even without it, I think all of this education in understanding how education works has helped me be a better teacher.

Q: Talk to me a little bit about the role models you have had in your career. How have they impacted you as a teacher?

A: There are three role models that have really impacted me. One is someone that is not in teaching, it was when I was in the corporate world, who was my manager. I was a young man at the time, and I had a good job, at least from anything I had had before, I was really into computers, and he took me under his wing and really helped me learn how to be a professional, before I had a clue how to do that. I had this lucky opportunity to get into this and he was really impactful to me, and gave me a lot of confidence and took me under his wing, and taught me a lot about the corporate world and how to represent yourself and how to be professional. Of course, my dad, he was in business and sales his all life, he was an entrepreneur for a time, he is just a really powerful role model to me. The third person was a teacher I worked with when I first started teaching in Texas. I learned a lot from him, but more than anything, content knowledge. If there was ever a time I couldn't solve a problem I would go to him, I was lucky to even be aware of my head talking to him. I just learned a lot about physics, a lot of things I didn't know, you know in teaching when you teach a subject you really don't know the subject until you teach it, you really learn it when you are teaching it, he really helped me understand how to take it to a new level and that you could really get kids more than I thought you could. You could challenge them more than I thought you could at a high school level, even though he was never assigned to be my mentor, he was older than my dad, I just kind of looked up to him even though he was a good friend as well.

Q: Is it your passion for science or your passion for students that interests you in this career or field?

A: I have got to say that if I go back in time, to when I first got into this profession, I was way, way more on the subject end, and it was the subject that motivated me I would have never told a principal that back then, I was so subject oriented, and everything I did was subject oriented and I ran into some problems in the beginning because of that. Over the years, that pendulum has shifted a lot into now realizing wait a second, it's really more about the students, you got to start with the student, not the subject, and I think, knowing what I know now, having taught for this long and going through the education, I realize it is the importance of starting with the student, and being student oriented, but people don't grow into being a great physics teacher, without loving physics. In my case, I was very motivated, very subject motivated to get into it to begin with. So teaching was the last thing I selected at the end, but it was one of the things on the list. But like I said, the pendulum has shifted way more to the student end, but still very compassionate about the science.

Q: What is the most rewarding experience from your career as an educator? Conversely, what is the most challenging thing about being a teacher?

A: OK, the most rewarding experience as a teacher is knowing that at times, realizing, that the kids are really getting it because of me, that I am impacting them, because you think as a teacher, are you really impacting students' lives in a positive way, they have a lot of teachers in their lives, they take a lot of classes, when I run into students later in life. I ran into a student recently, and the one thing he told me he remembered was doing those projects. And I remember back when we were doing those projects, and some of them seemed kind of flimsy, and I wondered if they were really teaching the kids physics, then I realized this is what the kids are remembering. They aren't remembering what I really wanted them to remember, they were remembering those goofy projects they did. I get a great sense of comfort or fulfillment, in my profession, that students are getting value out of what I am doing, even if I am a small part of their life. The expression on students faces when they get something where they used to struggle, when finally, something clicked, and I had a hand in that.

The hardest part about being a teacher is dealing with classes that are nothing but a whole bunch of management issues. It can go two ways, if you have all honors classes, I feel like I can get up and teach. Even experience, even a teacher that is experienced in classroom management, is going to have a tough time in a class where it is just a bunch of kids that have needs, and they are weak academically, and they are immature, and you are dealing with, and when you are compassionate about science, and you are trying to figure out ways to get students to learn, and when you are dealing with classes, where you have to just give them something to do, and all you are doing is managing behavior, because you can’t teach them anything until you get their behavior and your classroom management down, it is discouraging and it makes me want to get out of it.

Q: Anything else you want to add that I haven’t asked about?

A: People are going to go in, I think in general, I have come across a lot of people that were successful in industry, and they go into teaching and they are alternatively certified, or they were in industry, they probably had a good paycheck at one time and they go into teaching later in life, and that semi-parallels what I did, but not quite, there are people who have been very successful and they go into teaching, and they do it for various reasons, and it could be anything from the industry has changed, the market has changed, they have gotten laid off, or it could be they are just burnt out from what they are doing and they want to teach kids, they might look at it as maybe that is a better deal, and then they see what a teacher actually goes through and they may be a little regretful, they will realize that, but you know people go into for various reasons, but I think in general it is a powerful, powerful thing for schools to have those kind of individuals because they bring industry into it. They bring a background, a practical background, and they might not have that pedagogy down, that is where they will be lacking, but where they are lacking in that they have knowledge that someone who went from college to teaching, because they don't have that experience. They have that bigger picture knowledge they can share with the students. There should be programs that encourage those types of individuals to come into education. There should be bonuses, or money, or recruiting mechanisms to go after people like that, I think it would be advantageous to the profession.

Appendix B

UNIVERSITY of HOUSTON
DIVISION OF RESEARCH
Institutional Review Boards

APPROVAL OF SUBMISSION

October 27, 2017 Anthony Livecchi ajlivecchi@uh.edu

Dear Anthony Livecchi:

On October 5, 2017, the IRB reviewed the following submission:

Type of Review:	Initial Study
Title of Study:	The Opportunity Cost of Teaching for Secondary STEM Instructors
Investigator:	Anthony Livecchi
IRB ID:	STUDY00000541
Funding/ Proposed	Name: Unfunded
Award ID:	
Award Title:	
IND, IDE, or HDE:	None

Documents Reviewed:	• Final Consent Form , Category: Consent Form; • Livecchi Recruitment Email Updated 10-7.pdf, Category: Recruitment Materials; • Interview Questions, Category: Study tools (ex: surveys, interview/focus group questions, data collection forms, etc.); • Correspondence Response 10-7-17, Category: Correspondence (sponsor, IRB, misc.); • Livecchi Protocol Submission, Category: IRB Protocol; • Demographic Survey, Category: Study tools (ex: surveys, interview/focus group questions, data collection forms, etc.);
Review Category:	Expedited
Committee Name:	Not Applicable
IRB Coordinator:	Danielle Griffin

The IRB approved the study from October 5, 2017 to October 4, 2018, inclusive.

To ensure continuous approval for studies with a review category of “Committee Review” in the above table, you must submit a continuing review with required explanations by the deadline for the September 2018 meeting. These deadlines may be found on the compliance website (http://www.uh.edu/research/compliance/). You can submit a continuing review by navigating to the active study and clicking “Create Modification/CR.”

For expedited and exempt studies, a continuing review should be submitted no later than 30 days prior to study closure.

If continuing review approval is not granted on or before October 4, 2018, approval of this study expires and all research (including but not limited to recruitment, consent, study procedures, and analysis of identifiable data) must stop. If the study expires and you believe the welfare of the subjects to be at risk if research procedures are discontinued, please contact the IRB office immediately.

Unless a waiver has been granted by the IRB, use the stamped consent form approved by the IRB to document consent. The approved version may be downloaded from the documents tab. To document consent, use the consent documents that were approved and stamped by the IRB. Go to the Documents tab to download them.

In conducting this study, you are required to follow the requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the IRB system.

Sincerely,

Office of Research Policies, Compliance and Committees (ORPCC)
University of Houston, Division of Research

713 743 9204

cphs@central.uh.edu http://www.uh.edu/research/compliance/irb-cphs/