

KNOWLEDGE PRODUCTION IN THE UNITED STATES:
AN ANALYSIS USING THE THEORETICAL FRAMEWORKS OF MARX AND WEBER

by

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The increased reliance of knowledge in the United States has led to what is often referred to as an emerging knowledge-based society. Knowledge is important to several aspects of society (Campbell, 2006) and is produced in a number of settings (e.g., research universities, industry and government laboratories, independent research institutes, etc.) across the nation (Godin & Gingras, 2000). In terms of research, scholars and other professionals must have access to the appropriate resources (e.g., laboratories, funds, etc.) (Feldman & Florida 1994) to engage in knowledge production. Further, more knowledge is produced and distributed by the United States, largely through scientific journals, than anywhere else in the world (Phillips, 2016). This paper analyzes the production and distribution of knowledge through the sociological theory of Karl Marx and Max Weber. The primary goal of this study is to develop a better understanding of modern-day knowledge production and distribution processes as they result in one of the most important commodities in the United States. The theoretical framework Marx (1844/1848/1867) used to analyze capitalist production and distribution uncovers the means that are important in knowledge production and knowledge distribution, the parties involved in these processes, and

whether conflict exists between the parties involved. This analysis also underscores the need for more thorough examination of knowledge production in the twenty-first century using a Marxian framework. The theoretical framework Weber (1946) devised to understand stratification shows that resource divisions exist among researchers based on their unequal access to class, status, and political power; the unequal outcomes in knowledge production efforts result from such divisions. Using chi-squared tests this paper examines three hypotheses that emerge from the application of Weber's (1946) theory to researchers involved in knowledge production. First, I consider whether scientists have different amounts of class, status, and political power that influence the outcomes of their research. Second, I ask whether researchers' reliance on technological innovations such as infrastructure lessens the influence of status, and increases the effect of class on their stratification. My final hypothesis pertains to whether researchers' class and status are related to their political power. The results show interesting differences between natural and social scientists' access to class and status. The study indicates the need for future research examining a more comprehensive group of scientists and lays the groundwork for further examination of the applicability of Weber's (1946) stratification theory to researchers in the United States.

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CHAPTER 1

INTRODUCTION

In the twenty-first century, the United States and other advanced nations around the globe are considered to be “knowledge based” due to their increased reliance on knowledge (Campbell, 2006). In the United States knowledge is vital to several elements of society. Knowledge is closely associated with economic activities (Campbell, 2006). Specifically, knowledge is necessary for efficient and effective product creation within the United States’ advanced economy. Additionally, advanced nations maintain their positions in the global economy and increase their wealth by continually pushing to create new products and technologies. Knowledge is also noted as important in the realms of governance, education, and culture (Campbell, 2006). In regards to governance and politics, knowledge plays an important part in helping governments shape policy and make informed decisions. In the realm of education, knowledge is critical as it serves as the foundation for what a society will be taught in its education institutions. Knowledge also plays a crucial role in shaping the culture of a society which influences the attitudes and behaviors of the citizens within it (Campbell, 2006). However, knowledge, which has become vital to the United States and other societies, does not miraculously manifest itself. Knowledge must be produced, advanced, and distributed through the investment of both mental and physical labor. The labor required to produce knowledge is typically invested into practices of research (i.e., carrying out scientific pursuits for the purpose of discovery) and design (i.e., the creation of products to develop understanding) which result in science and technologies (Campbell, 2006). The production of knowledge requires the use of various resources beyond human capital including access to existing science and technologies

(Campbell, 2006). The distribution of knowledge generally occurs through authorship of journal articles containing the knowledge produced by research (Porter, 1964). Additionally, for knowledge to be distributed once it is written into the journal article it must be published, which requires mental labor (i.e., editors and reviewers) and access to various technologies (i.e., computers, printers, etc.).

Knowledge Production

Historically, knowledge production in the United States began as the result of the independent efforts of various researchers, businesses, and education institutions (Etzkowitz, 2001; Shils, 1978). Historically in the United States, higher education institutions did not give formal support to professors so they could conduct research, but they were often able to use their teaching labs and personal salaries to support their research endeavors (Etzkowitz, 2001). It was not until the mid-nineteenth century that professors at prominent higher education institutions in the United States (e.g., Columbia, Harvard, etc.) began diverting their attention away from teaching to collaborate with local business when producing knowledge (Shils, 1978). At the same time, universities began formally endorsing research as well by providing labs and student assistants for professors to perform research as part of their employment in higher education (Etzkowitz, 2001). Following the initial support for knowledge creation at universities, the supports underlying academic research were expanded even further during the Second World War (Etzkowitz, 2001; Shils, 1978). During the war the United States government recognized the vast potential of advancing science and technologies to aid the nation in its fight, and looked toward universities to help with increased research efforts (Campbell, 2006). The amount of knowledge produced in academia has continued to grow ever since World War II (Etzkowitz,

2001). However, research did take place outside of education institutions historically. At the beginning of the twentieth century, independent research institutions were established, such as the Carnegie Institute which supported knowledge production, independent of universities (Shils, 1978). Additionally, during the twentieth century industrial research laboratories owned by prominent companies (e.g., General Electric, etc.) began carrying out their own independent knowledge production efforts in an attempt to identify new products and increase their profits, but such endeavors also contributed to the advancement of knowledge simultaneously (Shils, 1978).

Knowledge Distribution

The history of modern day knowledge distribution, unlike the history of knowledge production, mostly predates the formation of the United States in the 18th century (Porter, 1949). As a result, to understand why knowledge distribution occurs as it does in the United States today it is necessary to look at how knowledge distribution evolved prior to the 18th century. In the 17th century, which was right around the time the Americas were first being colonized by the British and French, knowledge was being distributed through books, newspapers, and groups of scientists that initially met and communicated through the mail informally but eventually began to form into formal scientific societies (Andrade, 1949). Once scientific societies began to form, scientists in Europe and the American colonies began to meet and discuss the latest scientific findings and theories which they then transcribed and distributed in a printed format to others within the scientific society and their individual social networks (Porter, 1949). Eventually, scientists began to realize how restricting their methods of knowledge distribution were in ensuring a rapid and widespread distribution of current knowledge and began to explore new

ways of distribution (Porter, 1949). A development made in England in the mid-17th century would use the printing press to publish and distribute scientific findings outside of books and newspapers and revolutionize how knowledge was distributed in Europe and set the stage for how knowledge would be distributed in the United States (Andrade, 1949). In 1665, in England, the first scientific journal *Philosophical Transactions of the Royal Society* was established, published, and distributed in an effort to communicate the current findings and theories in the natural and social sciences (Porter, 1949). As time went on more journals began being published in Europe using this new format, and by the end of the 17th century approximately 30 different journals had been established to aid in the distribution of knowledge (Porter, 1949). In the late 18th century, journals began to take the shape they have today in the United States. They included mostly original experiments and were published in specialized journals that existed for each subject (e.g., physics, agriculture, etc.) (Andrade, 1949). By 1845, the first scientific journal was established in the United States, *Scientific America*, and over 300 journals were being published around the world (Shils, 1978; Porter, 1949). By the end of the 19th century, editorial boards were established by journal publishers, which employed scientists to review the journal submissions of their peers for validity and accuracy (Porter, 1949). Today, peer-reviewed scientific journals are the primary mode of knowledge distribution and are published in print and featured online, making current knowledge even more accessible to scientists around the world (Kirk & Corcoran, 1989; Phillips, 2016). More journals are published in the United States today than in any other country, even though the use of scientific journals for knowledge distribution has been occurring since before the United States was founded (Phillips, 2016; Porter, 1949).

Research Focus

With the enhanced reliance of modern society on knowledge, its production today occurs in increasingly diverse settings (Campbell, 2006). These settings include research universities, corporate-sponsored research laboratories, independent research institutes or think-tanks, hospitals, and government research facilities (Godin & Gingras, 2000). Knowledge production also involves the use of myriad resources (1994 Etzkowitz, 2001; Feldman & Florida, 2010; Godin & Gingras, 2000; NSF, 2016; Shils, 1978). Further, more knowledge is produced and distributed by the United States, largely through scientific journals, than anywhere else around the world (Phillips, 2016). Considering the fact that knowledge has become a vital commodity in the United States and other advanced nations it is important that the resources, processes, and parties involved in its production and distribution are analyzed and understood. Accordingly, this paper will analyze the production and distribution of knowledge through the theoretical lenses of Karl Marx and Max Weber. The theoretical framework Marx (1844/1848/1867) used to analyze capitalist production and distribution in the nineteenth century during the Industrial Revolution will be used to illuminate the resources or means that are important in knowledge production and knowledge distribution, the parties involved in these processes, and whether conflict exists between the parties involved. The theoretical framework Weber (1946) devised to understand stratification will be applied to knowledge production to determine if resource divides exist among researchers and, if so, whether the distribution of resources relevant to knowledge production lead to unequal returns for researchers. The goal of this analysis is to come to a better understanding of the modern-day production and distribution processes that result in one of the most important commodities known to man – knowledge.

CHAPTER 2

THEORETICAL FRAMEWORKS

Marx on Means of Production and Classes

When reviewing the writings of Marx (1844/1848/1867) it is easy to see he did not discuss knowledge in great detail. Marx's (1867) discussions of knowledge were entirely focused on its importance to capitalists whom he noted required it to compete with other firms and secure future profits. Not to say Marx (1867) did not recognize the importance and value of knowledge; he simply did not recognize it as a commodity in itself. His discussion of knowledge in capitalist economies was almost entirely preoccupied with its ability to reduce the input of labor into production and distribution by enhancing existing processes with machines and innovative shortcuts. Marx (1867) opted not to discuss in detail the need of capitalists to develop and disseminate knowledge in order to enhance their products and create new ones. Today, Marx's dialogue on knowledge has become even more outdated as knowledge has become vital to capitalist production and distribution since it is not simply used to enhance these processes, but labor and resources are actively invested in the production and distribution of knowledge itself to create more profit. However, it is possible to use Marx's writings to learn more about the production and distribution of knowledge than he explicitly put forth. By applying the theoretical framework developed by Marx to analyze the production and distribution processes that characterized the Industrial Revolution to the production and distribution of knowledge in a knowledge-based society today, insight into the creation of this vital good can be gained. This insight can help inform the resources and parties involved in knowledge production and distribution and whether conflict exists between such parties.

While he did not focus on knowledge, Marx (1844/1848/1867) did pay a great deal of attention to production in his writings. During the Industrial Revolution, he saw capitalists' main goal as production for the sake of exchange and the accumulation of personal profit. He believed that to truly understand capitalism, it was important to break down and analyze the core processes that create the commodities that result in capitalists' profits. According to Marx (1848), the production process is made up of means or forces of production. The means of production are made up of every resource that is vital to the production process privately owned by capitalists. This includes everything from the private property owned by capitalists to the factories that exist on said land which in turn house the machines that carry out the production of commodities with the aid of workers, and to the raw materials that are used as inputs into the production process to create the commodities that capitalists wish to sell. Marx (1859) also acknowledges that the means of distribution needs to be recognized when analyzing the core components of capitalism. He suggests the transportation that is required to take the products from the factories to the stores where they are sold, along with the stores where the products are sold, and all other resources required to distribute capitalists' commodities can be considered means of production. Accordingly, this paper will use the term *means of production* to jointly refer to the means required for production and distribution as described by Marx (1859).

Marx (1848) points out in a capitalist economy individuals' access to and private ownership of the means of production distinguishes them into economic groups or classes. Specifically, he identified two main classes that are based on their relation to the means of production. Based on Marx's (1848) theory, each classes' relation to the means of production, specifically whether they privately own the means or not, stratifies them into a subordinate or

dominant position in society. These classes are the proletariat or the laborers who do not own the means of production and must work to obtain wages if they wish to gain access to the resources necessary for survival (e.g., shelter, food, etc.). And, the bourgeois or the private owners of the means of production, who control access to the factories and resources and employ the laborers to make commodities that the owners sell for a profit, and in return pay the laborer a living wage. However, the wages paid to workers by the owners of the means of production, according to Marx (1867), are only large enough for workers to pay for the necessities of survival so they can continue working and are not sufficient for workers to become owners of the means of production themselves. The advancements in manufacturing and machines that came from the Industrial Revolution made it less and less possible for workers to simply obtain their own raw materials and produce commodities by hand to sell themselves. It became a requirement to privately own factories and machines if one truly wished to compete in the economic market. As a result, Marx (1848) states that laborers are subordinated by the owners of the means of production. Marx (1867) indicates that this relationship, born out of ownership and access to the means of production, leads to the exploitation of laborers by the owners. The laborers must accept the wages given to them by the owners of the means even if their labor is worth more than they are paid since they lack ownership and access to the means of production without employment from the owners. Additionally, according to Marx (1844), private ownership of the means of production also leads to the alienation of workers who often cannot control what capitalists require them to produce. Alienation results when laborers must ignore their human capacities to be creative and subsequently the products of their labor lose human qualities as they become mere pieces of the production process under the reign of capitalists.

Weber on Stratification

Weber (1946), like Marx, did not discuss knowledge in great depth in his writings. His discussion of knowledge is limited to his analysis of the bureaucratic organizational structure that came to dominate in the twentieth century (Weber, 1946). Weber's (1946) analysis of bureaucracies only discussed the importance of knowledge to the workings of bureaucratic organizations that are continually seeking to obtain efficiency in organizational operations. However, Weber's (1946) theory of stratification based on class, status, and party focuses not on knowledge, its production, or the parties involved in it, but instead on the unequal access various groups have to important resources throughout society. Although Weber (1946) did not discuss the stratification among the participants of knowledge production, such as among researchers, the major themes he developed to examine stratification can still be readily applied to the distribution of resources among those involved in knowledge production today. Specifically, his theory of stratification provides a framework that can be used to analyze whether resource divides exist among researchers and, if so, whether they lead to unequal returns for them while considering, not just their class and each class's relationship to the means of production as Marx (1844/1848/1867) was preoccupied with, but also their status and power. As a result, Weber's (1946) theory of stratification enables the consideration of important societal resources that Marx (1848) does not discuss in his writing on class. This means Weber's framework for stratification analysis can be used to examine groups based on their relation to the means of production, but also based on their access to resources that have nothing to do with the means of production making his framework flexible compared to that developed by Marx (1848).

According to Weber (1946), major divisions occur in society based on access to three important resources. The first resource that he describes as vital to the stratification in society is class. His idea of class is focused on individuals' economic positions within the market and thus their economic position within society. Weber (1946) states that an individual's class is based on ownership and access to the resources important for production, much like the means of production described as essential to one's class position by Marx (1848). Unlike Marx (1848), Weber's (1946) definition of economic class is not limited to considerations of who does and does not own the resources vital to production and distribution processes. Rather, he sees class divisions also coming from all the different types of commodities and assets individuals own that have value in economic markets. For instance, he indicates beyond individuals' relation to production, it is also important to consider their ownership and access to liquid forms of money or capital. Weber (1946) states that the various assets and commodities that individuals own that have capital worth and thus could be liquidated into capital must also be considered when thinking about economic class. Examples in society of the major assets and commodities that individuals can own that impact their class position include the ownership of land, houses, cars, and even jewelry and clothing as they have capital value in the market. Further, ownership of such assets and goods can enable individuals to receive additional capital returns even without their direct liquidation into capital through means such as rental. By including the consideration of ownership of any goods that have monetary value into his conceptualization of class, Weber (1946) highlights how an individual's ability to obtain capital and thus their position in economic markets is not solely based on ownership of goods that are related to production. Weber's notion of class does not attempt to place individuals into two distinct classes only based on their relation

to the means of production. Weber's (1946) conceptualization of class instead allows for more than two distinct groups to emerge from the economic divisions in society. As a result, stratification based on class from Weber's point of view can form myriad groups based on their position within economic markets which is shaped by individual ownership and access to production processes, capital, or goods. Weber (1946) indicates that the class that individuals belong to, based on their position within markets, ultimately creates and shapes their life opportunities. Accordingly, the class an individual belongs to can impact life positively or negatively depending on whether their economic position in the market is considered high or low. On the one hand, this is similar to Marx's (1848) concept of class which tells us that class determines whether individuals are in dominant or subordinate positions in society and whether they have to labor or can simply profit off of the labor of others based on their ownership of the means of production. On the other hand, Weber's (1946) notion of class focuses not only on how individuals are placed into dominant or subordinate positions in relation to another class, but also on how an individual's market position shapes a large number of the opportunities in their life. Ultimately, Weber (1946) sees class as an important factor in the divisions that occur in society, but he did not see it as the only factor in stratification as Marx (1848) did. Weber (1946) diverges from Marx (1848) by believing more than just class determine people's opportunities and life chances such as the amount of status and political power they have.

Weber's (1946) writings on stratification go beyond Marx's (1848) by introducing the potential status has to influence the divisions and groups that form in society. According to Weber (1946), the status an individual has describes their honor, prestige, or popularity within a society or community. While the position of individuals within economic markets influences

their class position, the position of individuals within the social order determines the amount of status they possess. As a result, the status an individual has shapes the aspects of their life that are determined by prestige, honor, and popularity. This means prestige determines status, and at the same time, status can create opportunities in realms where prestige is of importance.

However, this is not all status can do for an individual. Weber (1946) indicates that stratification based on status aligns with the distribution of opportunities and resources throughout society. This can be seen in the fact that status determines the type of lives individuals lead. For instance, an individual's status can be seen in the types of clothes they wear, the food they eat, and their other patterns of consumption and it can be seen in their associations with others who share a similar lifestyle. Although status is not shaped by class, or at least not entirely, Weber (1946) notes that class and status are often associated with one another. Weber (1946) suggests this is due to the fact that those in higher economic classes often have a high status, albeit varying amounts. Although class or market position or the absence thereof, often determines individuals' style of life and thus the status they convey, it is not the only factor. Status does not guarantee individuals a certain class position. In other words, individuals that possess the same class resources do not necessarily have the same status. This is due to the fact that in the social order honor, prestige, or popularity and not class resources cause stratification by status. For example, factors such as the prestige of an occupation or how class resources are obtained can cause different status outcomes for individuals within similar economic classes. This is why a successful entrepreneur with a lot of class resources can have high status and simultaneously an artist whose work is revered but has less class resources can also have a high status. This disconnect between status and class enables all individuals in society, those that belong to both

lower and upper classes, to seek status. Weber (1946) highlights that the disconnect between class and status can be seen easily throughout history. In periods of less stratification by class it can be seen that status becomes a prime determinant of societal inequalities, while in periods of more stratification by class, status becomes less important to the divisions in society and the subsequent distribution of resources. Weber (1946) also notes that the technological innovations throughout history have also reduced the influence of status but increased the effect of class on stratification. It is not that status is no longer important in the societal division that exists today, class has just come to influence life chances slightly more over time. On top of considering both class and status, the other reason Weber's theory of stratification is a good framework for analyzing inequalities in society is due to his attention to political power and its potential to shape divisions and unequal outcomes in society.

According to Weber (1946), the party or political power an individual has must also be considered, on top of class and status, when analyzing stratification in society. While class is shaped by economic markets and status determines an individual's place in the social order, the political power one possesses determines their fate in the legal order. His use of the term *legal order* not only refers to the realm of government laws but also indicates the ability of political powers to influence any type of formal or informal laws or rules including policies and regulations in place in organizations. Weber (1946) describes political power as the ability to reach goals despite resistance. Political power can be thought of in relation to individuals' positions in hierarchical structures. Those at the top of the structure have more power or the ability to more easily find their way around rules and influence outcomes due to their political power. Additionally, Weber indicates that this political power is commonly exercised in the form

of organized parties within communities. These parties use this power to influence an action in a community. This goal can stem from both personal or group goals. Although class and status' relationship can be ambiguous as they can influence and be at odds with each other, class and status are more clearly both related to political power. Weber (1946) states that class and status can be seen shaping power in the legal order. For example, individuals with a high class or status position can use the benefits and opportunities granted to them by these resources to give themselves and their party more political power and influence outcomes in the legal order. Also, class and status can both be shaped by the political power of one's party. For instance, the existence of political power can enable individuals and parties to obtain goals they set in the market or social order and thus shape their class and status with the power they hold in the legal order. Additionally, Weber (1946) states that political power can be based on class interests and/or status interests. However, parties are commonly made up of individuals that come from both class and status groups and are rarely shaped by a single class or status interest. To attain political power individuals and parties can take numerous approaches. They can use economic resources, social influence, suggestion, and other subtle methods to obtain political power. Or, they can use protesting, violence, threats, and other blunt methods to obtain it. In the end, the inclusion of considerations of status and political divisions on top of class divisions is the reason that Weber's (1946) theory of stratification can be a powerful tool in understanding inequality in society. Unlike Marx's (1848) writings on how class underlies all societal inequalities, Weber's theory helps us understand how individuals with similar economic resources have varied opportunities and outcomes, how individuals that lack economic resources can still obtain good outcomes through their position in the social order, and how individuals from various class

and/or status groups can band together as parties and exercise their position in the legal order to benefit their own interests.

The next two chapters of this paper will analyze the production and distribution of knowledge through the theoretical lenses of Marx (1844/1848/1867) and Weber (1946) that were outlined in this chapter. Chapter Three will uncover what can be learned from applying the framework of Marx's (1844/1848/1867) theory on production in capitalism to the production and distribution of knowledge. Specifically, the chapter will analyze the production and distribution of knowledge in the United States in the twenty-first century and pay close attention to the means of production, and how access to these means influences those involved and the outcomes they receive. Using this analytical framework to examine knowledge production and distribution will help establish a better understanding of this important production process and distribution process, the resources and parties involved, and the outcomes that result from the arrangement of knowledge production and distribution currently practiced in the United States. Chapter Four will analyze divisions that exist among researchers involved in knowledge production through the lens of Weber's (1946) stratification theory. This will be done by reviewing researchers' access to class, status, and political power during their knowledge production efforts in the United States. The application of this theoretical framework will be used to determine if resource divides exist among researchers and, if so, how the distribution of resources relevant to knowledge production and distribution lead to unequal outcomes for researchers in the United States.

CHAPTER 3

KNOWLEDGE PRODUCTION AND CLASSES

Means of Knowledge Production

In order to analyze modern-day knowledge production and distribution in the United States it is necessary to first identify the means or forces of knowledge production. To determine the important means of knowledge production, a review of published scientific literature discussing science, research, and knowledge production and distribution was carried out. The following analysis of the means of knowledge production identifies resources that are indicated in the literature as being vital to the production and distribution of knowledge. The literature review led to the identification of three important means of knowledge production – infrastructure, funding, and publication.

Access to the appropriate infrastructure is a key mean of knowledge production (Etzkowitz, 2001; Feldman & Florida, 2010; Godin & Gingras, 2000; NSF, 2016; Shils, 1978). Infrastructure refers to the need for researchers to have access to laboratories with the technologies and resources appropriate to their research endeavors. For instance, a chemist undertaking research requires the appropriate infrastructure (e.g., chemicals, measuring devices, means of waste disposal, etc.) in order to effectively research and produce knowledge relating to chemistry (Feldman & Florida, 2010). In the United States, infrastructures that facilitate research and thus knowledge production can be found at the settings of modern day knowledge production (e.g., government and industry laboratories, research universities, independent research institutes, etc.). However, it has been noted by several sources that a majority of knowledge production occurs in two of these settings – industries and research universities

(Etzkowitz, 2001; NSF, 2016). In other words, just as Marx identified factories and machines as necessary for capitalistic production, an infrastructure appropriate for research is an important mean of knowledge production in the United States. Further, access to this infrastructure can be obtained through researchers' associations with various types of entities (e.g., government agencies, industries, independent think-tanks, etc.), but the literature notes that most of the United States' knowledge is produced by industries and research universities (Feldman & Florida, 2010; National Science Foundation [NSF], 2016; Shils, 1978).

Funding is also a vital mean for knowledge production (Blumenthal, Campbell, Causino, & Louis, 1996; Goldfarb, 2008; NSF, 2016). Although ultimately knowledge can result in profits from new products and technologies, its production requires an investment. Marx (1867) indicated in his analysis of industrial capitalism that it takes capital to make money. The same can be said when it comes to knowledge production; access to initial sources of economic capital is required (Etzkowitz, 2001). This capital is necessary for researchers to obtain the additional supports they need (e.g., human, technological, etc.) that are not provided through the research infrastructure they have access to (Campbell, 2006; NSF, 2016). However, unlike capitalists, researchers are not required to have large stores of their own personal funds set aside in order to produce knowledge. Rather, researchers obtain funding from various sources (NSF, 2016). In the United States, a majority (65%) of the funds being invested into knowledge production come from industries (NSF, 2016). The second largest source (27%) of funding comes from the federal government. The remainder of the funds that go to knowledge production (8%) come from state governments, universities, and independent research institutes (NSF, 2016). However, these sources of funding do not simply give financial support to researchers to create whatever type of

knowledge they desire. Rather, funds are commonly granted to researchers to explore specific topics and questions, and several sources indicate that government and industry demands are increasingly shaping the research endeavors that are funded (Goldfarb, 2008; Varma, 2000).

The last mean of knowledge production identified in this analysis is publication, which is an important aspect of knowledge distribution in the United States. Throughout the scientific literature there are multiple references to the importance of distributing knowledge by publishing it once it is produced (Kirk & Cocoran, 1989; Porter, 1949; Tzaranas & Tzaranas, 2015; Smith, 2006). Today, the distribution of knowledge is commonly carried out using peer-reviewed scientific journals, which is the same way knowledge was distributed when the United States was founded (Phillips, 2016; Porter, 1949). Marx (1848) indicates that commodity distribution is an important mean of production in capitalism. Accordingly, publishing in scientific journals is one of the key means of knowledge production. This is because, in the past and today, the publication of knowledge in journals increases the number of scientists and other interested parties that have access to it, which ultimately enhances its circulation (Porter, 1949; Smith, 2006). Publication in a peer-reviewed journal is seen as an indicator that knowledge has been vetted to ensure its scientific validity and precision (Smith, 2006). Further, the number of publications a researcher has and the number of times other researchers reference those publications are considered measures of scholarship among the scientific community (Tzarnas & Tzarnas, 2015). Publication of knowledge once it has been produced can also result in capital returns for researchers (Kirk & Cocoran, 1989). Once knowledge has been produced with the appropriate infrastructure and funds, publishing in scientific journals indicates it has been finalized, enables its dissemination, and creates opportunities for researchers to receive capital from their work, making it a

significant means of knowledge production (Kirk & Cocoran, 1989; Smith, 2006; Tzarnas & Tzarnas, 2015).

In the end, the means of production identified in this analysis as important for producing knowledge bear a close resemblance to the means Marx (1867) indicates are necessary for production in industrial capitalism. Both forms of production require access to the proper facilities and instruments so production can be carried out. In Marx's (1867) case, these included the factories and machines necessary for industrial manufacturing, whereas in a knowledge-based society, these include access to the appropriate laboratories and technologies necessary for scientific research (Feldman & Florida 2010). Both types of production also call for access to economic capital. In industrial production this capital is generally the property of the capitalist who then invests it into their own ventures so production can occur and profits can be made (Marx 1867). However, when it comes to knowledge production, economic capital must be obtained by researchers from funding sources and invested into their research pursuits (Blumenthal, Campbell, Causino, & Louis, 1996). Both arrangements of production also demand the distribution of finalized products. For Marx (1859) the distribution of commodities meant their transportation from factories to stores so they could be exchanged for capital. In the case of knowledge production, this distribution is carried out through a process of publication that enables the circulation of knowledge and creates opportunities for researchers to get capital returns (Kirk & Cocoran, 1989; Smith, 2006)

So far in this paper, the application of Marx's theoretical framework of production in capitalism has led to the identification of the means that are necessary for knowledge production in the United States – infrastructure, funding, and publication. Further, this analysis has

illuminated the fact that two of these means are owned by the same entities. That is, industries, the government, research universities, and independent organizations in the twenty-first century own and allow researchers to access both the appropriate infrastructures and funds they need when they produce knowledge (Blumenthal, Campbell, Causino, & Louis, 1996; Etzkowitz, 2001; Feldman & Florida, 2010; Godin & Gingras, 2000; Goldfarb, 2008; NSF, 2016; Shils, 1978). On the other hand, scientific journals are owned by separate entities (Porter, 1949).

Classes and Outcomes

Just as Marx (1844/1848/1867) identified groups or classes of individuals based on their relation to the means of production in capitalism, classes can be identified based on their relation to the means of knowledge production today. The classes defined in Marx's (1848) writings can be seen as being composed of two main groups – those that owned the means of production and those that did not. A similar distinction can be made for the classes involved in knowledge production. On the one hand, there are the researchers who do not own the means of production, and who are similar to the class of laborers that Marx identified in his writings. The laborers required access to the factories and machines necessary to produce commodities which were owned by capitalists and were grouped into one class (Marx, 1848). Similarly, in the knowledge-based society a class of researchers must obtain access to the appropriate funding, technologies, labs, and publishing bodies so they can invest their labors into research to produce and distribute knowledge (Feldman & Florida, 1994). On the other hand, there are the owners who possess the means of production. During the Industrial Revolution Marx (1848) identified the owners of the factories and machines that grant laborers access to the means of production as another class of individuals. At the same time, in the twenty-first century the means of knowledge production are

also possessed by an identifiable class of actors (e.g., governments, industries, research universities, independent institutes, and publication entities) which grant researchers access to the means so they can produce and distribute knowledge (Campbell, 2006; NSF, 2016).

When analyzing the production and distribution of knowledge, the two classes, the means involved, and who owns those means appears to be similar to the findings of Marx's (1848) analysis. In both instances, dichotomous classes form based on their relationships to means of production. Further, it appears that just as the owners of the means of production in capitalism are in a dominant position, so are the owners of the means of knowledge production who decide which researchers have access to the means. And, just as those who do not own the means of production in capitalism are placed in a subordinate role, due to their lack of ownership yet simultaneous reliance on the means of production, researchers are also put in a subordinate role today. When researchers wish to produce knowledge they need access to the appropriate infrastructure, funding, and means to publish their efforts, which they do not own or control and must rely on the owners to supply. Marx (1867) identifies that the owners of the means of production exploit the laboring class by paying them less than their labors are worth. He suggests that workers are only paid enough to survive to ensure owners get profits from the means of production they own. Although researchers are put in a subordinate position to the owners, due to their reliance on the means of knowledge production, it is unlikely that researchers are exploited in this relationship. Unlike the time during which Marx (1867) identified worker exploitation, today in the United States there are laws that exist to protect workers (Attas, 2000). In the United States workers are guaranteed a minimum wage, the right to organize, and the freedom to move between jobs to protect themselves from exploitation. In this analysis of

knowledge production, however, the profits of the owners of the means of production and the wages garnered by researchers are not reviewed, so it is not possible to claim that researchers are or are not exploited in their subordinate positions by the owners of the means of production.

Although this analysis does not fully explore whether researchers are exploited during knowledge production, it does uncover that they may be alienated in certain circumstances. In their subordinate roles researchers are reliant on those who own the means of production to grant them access, and based on Marx's (1844) theory the researchers could be alienated in the process. Specifically, this alienation may occur because industries and the federal government fund a large majority of research, but these entities only fund certain research topics (NSF, 2016; Varma, 2000). For example, industries are most interested in knowledge that leads to new technologies and increased profits, and the government is largely interested in socially beneficial research topics such as those focused on alternate energy sources, medicine, and national defense (Goldfarb 2008; Varma 2000). As a result, researchers are increasingly forced to suppress their personal research interests and pursue knowledge production involving topics that are being funded by industry and government entities (Goldfarb, 2008). Marx's (1844) framework suggests that due to private ownership of the means of knowledge production and the lack of control researchers have over these means, they may become alienated during production. Specifically, because the owners of the means of knowledge production only fund certain topics, researchers could become alienated during production because they lose their autonomy to produce knowledge that interests them. Just as Marx (1844) saw laborers were becoming pieces of the machines employed in factories due to their alienation, today researchers may become mere research instruments within labs. Accordingly, Marx's (1844) framework leads to the

identification of the hypothesis that in the current arrangement of knowledge production, researchers must ignore their human capacities of self-interest and pursue research topics that interest the owners of the means of production instead – becoming alienated in the process. In fact, this hypothesis is supported by at least one prior research study. In an investigation into alienation in a private aerospace company, Miller (1967) found that industrial engineers and scientists were being alienated in their work due to their lack of autonomy and control of their research. This example shows that researchers within one company were being alienated, but it does not fully support the hypothesis that industrial researchers or all researchers for that matter are being alienated. Studies need to continue to investigate the relationship between alienation and the current knowledge production process to determine if the hypothesis that emerges when applying Marx's (1844) theory of alienation can be accepted or rejected.

Marx's (1844/1848/1867) theoretical framework of production in capitalism has led to the identification of the means involved in knowledge production, classes based on their ownership and access to said means, and the fact that one class may be alienated in this production process. However, this analysis also underscores the need for future and more thorough examinations of the production of knowledge in the twenty-first century using Marx. For example, future investigation could attempt to uncover any additional means of knowledge production that this analysis may have overlooked. Future studies can also attempt to determine whether researchers are exploited or not in their subordinate relationships to the owners of the means of knowledge production. Future research should also attempt to confirm the finding of this theoretical analysis and Miller's (1967) study that suggests researchers are alienated during their knowledge production efforts due to their inability to explore and study the topics and

questions in which they are personally interested, but instead pursue the topics of interest to the owners of the means of knowledge production.

CHAPTER 4

STRATIFICATION AMONG RESEARCHERS AND OUTCOMES

In the previous chapter, the application of Marx's (1844/1848/1867) theoretical framework to knowledge production in the United States led to the emergence of two classes - owners and researchers. Marx's theory surrounding capitalist production can be used to view knowledge production through a unique lens and help identify the major players involved, but it also has its limitations. Focusing on their ownership or lack of ownership of these means depicts them as homogenized groups only characterized by class. Despite researchers' common reliance on the means of knowledge production, it is important to consider the differences that exist among their access to these means as well as other types of resources not considered in Marx's (1844/1848/1867) analysis of capitalist production. When it comes to the outcomes of researchers' knowledge production efforts, there are documented differences in the outcomes and in the returns researchers obtain for their labors in the United States. Scholars indicate that the outcomes of researchers' production efforts are not all equal and can differ in the amount of knowledge they produce, whether the knowledge they create even gets published, and if it is published, the impact their findings have on the scientific community (Guedo, 2001; Kirk & Cocoran, 1989; Smith, 2006; Tzarnas & Tzarnas, 2015). In order to further explore why different outcomes exist for researchers, it is important to consider the extent of all the resources they have access to. Weber's (1946) theory on stratification enables the consideration of important resources that Marx's (1848) does not discuss in his writing on capitalist production, which were preoccupied with class. This means Weber's stratification framework can be used to examine groups based on their relation to the means of production and other measures of class,

but also based on their access to status and political power, making his framework flexible compared to that developed by Marx (1848). Since Weber developed his theory of stratification in an attempt to understand divisions across society and not to examine capitalism like Marx, it is an ideal framework to understand the divisions that exist among researchers in the United States today and whether such divisions cause the unequal outcomes researchers experience from their knowledge production efforts.

Class

To view researchers through the lens of Weber's (1946) theory of stratification, first, class differences among researchers will be analyzed. Even though applying Marx's (1848) theory of class to researchers indicates that they all share a similar class position, Weber's (1946) conceptualization of class is not limited to who owns the means of production. Rather, Weber's notion of class is focused more on an individual's overall market position which is made up of an individual's ownership and access of production process as well as the different types of commodities and assets individuals own that have value in economic markets. Accordingly, a literature review was conducted to identify the class differences that exist among researchers, and whether differences in their access to class resources leads to the unequal outcomes of knowledge production that results from their labors. The application of Weber's (1946) stratification theory to researchers in the United States indicates that they have different access to the means of knowledge production identified with Marx's (1848) theory (Blumenthal, Campbell, Causino, & Louis, 1996; Godin & Gingras, 2000; Goldfarb, 2008). Although researchers in the United States share in their lack of ownership of the means of knowledge production, they differ in who owns the means they produce knowledge with, which shapes their

access to said means (Godin & Gingras, 2000; NSF, 2016). As noted in the previous chapter, there are several different entities that own and supply researchers with the funding they need to produce knowledge. The main entities that researchers obtain funds from in the United States are industries, the federal and state governments, universities, and research institutes (NSF, 2016). Further, depending on which entity owns the funds, which are given to researchers for their use in knowledge production, the amounts provided to researchers vary (NSF, 2016). The source of funds matters because each entity that owns the funds necessary for research has different amounts available to researchers and thus do not provide all researchers with the same levels of funding (NSF, 2016). And, the different levels of funding provided to researchers can be enormous as some researchers may be provided with thousands of dollars to produce knowledge, while others may obtain millions of dollars to carry out their endeavors (NSF, 2106; Godin & Gingras, 2000). In other words, when considering class position as being more than the ownership of means of production, as Weber (1946) did, the amount of funding researchers have access to and thus their class positions vary depending on the source of funds and the amounts they obtain from said sources. Additionally, it has been noted that the source of researchers' funding does in fact impact the outputs of their knowledge production efforts. Specifically, the source of researchers' funds can impact whether their production efforts result in publication, which is a large measure of success in the academic community (Blumenthal, Campbell, Causino, & Louis, 1996; Goldfarb, 2008). For example, Blumenthal et al. (1996) shows that funds coming from industry, which provides the most research funding in the United States, provides positive results from researchers when it comes to publication. Accordingly, just as Weber (1946) indicates unequal access to class resources causes unequal life outcomes in

society, when it comes to knowledge production, class differences among researchers appear to lead to unequal outcomes from their production efforts.

Researchers' unequal access to class resources is not limited to their access to funding, but also can be seen in their access to research infrastructures. As mentioned in Chapter Three, beyond the source of researchers funding, the physical place where they produce knowledge at also varies in the United States. The main research locations are higher education institutions, industry-sponsored laboratories, government research facilities, independent research institutes or think-tanks, and hospitals (Godin & Gingras, 2000). Further, there is evidence that indicates the research infrastructure at each of these locations is not equal (Godin & Gingras, 2000). Every library is not equipped with the same books just as every laboratory does not possess the same materials and equipment, which means researchers do not have access to the same or even equivalent infrastructures when producing knowledge. Just as researchers do not own the funding and thus get different amounts to use when producing knowledge, they also do not own the research infrastructures they access which causes them to have unequal access to the materials and equipment necessary for knowledge production. When conceptualizing class differences as Weber (1946) did by considering more than who does and who does not own the means of production, researchers' class positions vary based on the infrastructure they have access to and its ability to meet the material and equipment demands of their research efforts. Additionally, sources indicate the various infrastructures researchers have access to do influence their knowledge production efforts and the outcomes of said efforts (Godin & Gingras, 2000; Feldman & Florida, 2010). Godin and Gingras (2000) found the infrastructure researchers produce knowledge with can determine the overall amounts they create, and that universities

have the most research output and can even increase the research produced at other locations (e.g., industries, hospitals, etc.) through joint ventures. Feldman and Florida (2010) provide further evidence of the influence of infrastructure inequality on knowledge production by showing that it shapes the geographic distribution of innovation and research occurring in the United States. Such examples show through the lens of Weber (1946), class differences emerge among researchers based on the funding and infrastructures they have access to. Further, just as Weber (1946) states class position influences people's life chances, the class position researchers obtain, based on their access to the means of knowledge production, may be shaping the amounts of research they produce and the quality of the research they produce (Blumenthal, Campbell, Causino, & Louis, 1996; Feldman & Florida, 2010; Godin & Gingras, 2000; Goldfarb, 2008). Although analyzing researchers with Weber's (1946) stratification theory has helped identify how class divides exist among researchers, who all lack ownership of the means of knowledge production, more information concerning the divides among researchers can be obtained by analyzing the differences in their access to status and political power. These resources which Marx (1848) did not even consider, could also be shaping their knowledge production efforts and the outcomes of their efforts.

Status

Now that class differences among researchers have been reviewed using Weber's (1946) stratification theory, status differences will be examined. Weber (1946), unlike Marx (1848) does not believe that the divisions within society are restricted to ownership of the means of production or market position; instead he considers the potential status has to determine the stratification that emerges in society. According to Weber (1946), the status an individual

possesses is indicated by their honor, prestige, or popularity within society or a community.

Across the literature there are several indications of status differences among researchers (Bjork & Solomon, 2012; Cole 1970; Guedo, 2001; Merton, 1988; Tzarnas & Tzarnas, 2015). Tzarnas and Tzarnas (2015) show that in the scientific community, success is often associated with the number of publications and citations a researcher receives during their career. Additionally, scholars have even taken the time to devise methods to measure the amount of scientific impact or “success” researchers have over a specific period of time or throughout their careers (Guedo, 2001; Tzarnas & Tzarnas, 2015). These measures are typically derived by comparing the number of scientific publications, the amount of knowledge a researcher has fully produced, and the amount of times other members of the scientific community reference these publications (Guedo, 2001). Further, these measures indicate status differences among researchers based on Weber’s (1946) theory because when researchers’ knowledge production efforts are highly referenced in the efforts of others they gain popularity in the scientific community (Tzarnas & Tzarnas, 2015).

At the same time, scientific journals, the current most popular medium for publishing produced knowledge (Phillips, 2016), are also ranked based on measures of their impact. These rankings are devised by comparing the number of articles published in each journal to the number of times scientists referenced the publications within them (Garfield, 2006). According to some, these journal rankings demonstrate the quality of the research each journal contains when compared to others (Garfield, 2006; Saha, Saint, & Christakis, 2003). The consideration of journal rankings is important because highly ranked journals may be thought of as publishing better quality research subsequently increasing the number of individuals that read them. In other words, the journals where research is published vary in status based on Weber’s (1946) framework (Saha, Saint, &

Christakis, 2003). Accordingly, as Weber's (1946) theory of stratification would suggest, status inequalities exist among researchers and can stem from individuals' measures of scientific impact that indicate varying degrees of success and popularity, and they can result from the rankings of the various scientific journals in which researchers publish their findings.

As with class, scholars note that the status of researchers and the journals in which they eventually publish the knowledge they produce, influences the outcomes and returns of their efforts (Bjork & Solomon, 2012; Cole 1970; Guedo, 2001; Merton, 1988; Saha, Saint, & Christakis, 2003). Merton (1988) indicates that researchers not only have status differences based on the knowledge they have produced, but that such status can have large impacts on their future production efforts. Specifically, he shows that as researchers publish the knowledge they produce, they accumulate status which increases the opportunities they have for research as well as the outcomes and rewards of it, such as the number of times their knowledge is referenced and returns on capital from their efforts (Merton, 1988). Cole (1970) has also shown that the scientific impact or status associated with researchers can lead to positive benefits such as how fast their produced knowledge is disseminated among the scientific community and the attention their papers receive from others which further increases their status. On the other hand, the status of scientific journals in which researchers publish their knowledge shapes the outcomes and returns researchers receive. Studies also indicate that journals can be thought of as brands and publishing knowledge in high-status journals increases its visibility and leads to potential for increased capital returns for research (Guedo, 2011; Bjork & Solomon 2012). Accordingly, just as Weber (1946) identifies that status divisions exist across society and shape the outcomes that individuals experience, evidence suggests the same may be true for researchers who are noted to

have status differences and unequal outcomes for their knowledge production efforts based on said status. Further, the existing findings that indicate increased capital returns for research based on their status (Bjork & Solomon, 2012; Guedo, 2011; Merton, 1988) also support Weber's (1946) theory, which indicates the potential of status and class to be associated with one another in certain circumstances. So far, Weber's (1946) theory has helped illuminate the power of class and status to divide researchers and lead to different outcomes for their knowledge production efforts. However, according to Weber (1946), the impact of class and status are not the only determinants of divisions in society and differences in researchers' access to political power and whether such differences lead to unequal outcomes for them also needs to be considered.

Political Power

So far this chapter has examined the application of Weber's (1946) stratification theory to researchers' class and status to understand the distribution of these important resources among them and the potential for negative outcomes to emerge for said distribution. To truly understand the stratification of researchers through the lens of Weber's (1946) theory, it is important to review the differences in researchers' access to political power and the outcomes that stem from them. Weber (1946) indicates political power is realized in the legal order and enables individuals to reach goals without resistance through the influence of formal and informal policies enacted by governments and organizations, and can often be thought of in relation to individuals' positions in hierarchical structures. Several examples of divisions among researchers based on political power exist (Bland et al., 2006; Blumenthal, Campbell, Causino, & Louis, 1996; Confessions, 2011; Haak, 2002; Sellers-Rubio, Mas-Ruiz, & Casado-Diaz, 2010). For instance, it has been shown that the hierarchical position academic researchers hold within

institutions of higher education can influence the amount of knowledge they produce (Bland et al., 2006). Specifically, Bland and colleagues (2006) found that tenured compared to non-tenured researchers produce two to three times more knowledge. Based on Weber's (1946) theory it appears that the academic appointment held by researchers may increase the political power granted to them within their organizations and thus enable them to obtain their goals of knowledge production. Further, a tenured appointment within an institution is generally only granted to researchers that have obtained great status through their research endeavors which aligns with Weber's (1946) notion that status and class can shape political power (Sellers-Rubio, Mas-Ruiz, & Casado-Diaz, 2010). This political power can even be thought of as coming from a party of researchers, which Weber (1946) indicates political power commonly stems from, who share common goals based on their academic appointments and their common access to resources important to knowledge production. Other scholars have documented examples that suggest differences among researchers' political power in academia based on their participation in governance activities at their universities (Blumenthal, Campbell, Causino, & Louis, 1996; Sellers-Rubio, Mas-Ruiz, & Casado-Diaz, 2010). Higher education institutions have open forms of governance which allows researchers to be appointed to administrative positions and continue to participate in research (Sellers-Rubio, Mas-Ruiz, & Casado-Diaz, 2010). Such administrative appointments would potentially allow for researchers to obtain goals through their influence of institutional policy. Researchers that participate in administrative activities appear to also make up a party of individuals with the power of governance and are generally also appointed to such activities based on their status within the institution as Weber (1946) would predict. The positive relationship between researchers' participation in administrative activities and the amount of

knowledge they produce suggests the existence of political power as Weber (1946) describes it (Blumenthal, Campbell, Causino, & Louis, 1996; Sellers-Rubio, Mas-Ruiz, & Casado-Diaz, 2010). Additionally, scholars indicate that participation in the editing of peer-reviewed scientific journals can provide benefits for researchers in their efforts of knowledge production (Confessions, 2011; Haak, 2002). Researchers' participation in editing academic journals appears to place them within a party of fellow journal editors which can enable positive returns suggesting the influence of political power in such situations as Weber (1946) describes it. Further parallels can be drawn from Weber, who suggests that status and class can influence political power, which can be seen in this situation as researchers that edit journals are often those that have garnered status within their fields of study (Haak, 2012). Once researchers have been selected to participate as editors for journals they are placed in a position of power which enables their ability to influence how the certain policies of journals are carried out, which can shape what knowledge gets published and thus fully produced (Confessions, 2011; Haak, 2002). The positive returns that have been documented as benefiting researchers that participate in journal editing include specific knowledge of the policies and procedures that govern journal editing giving them an upper hand in preparing their submissions of produced knowledge to journals, as they can ensure the important criteria which editors look for, is satisfied in their work (Confessions, 2011). Additionally, in some rare cases bias may exist among journal editors when reviewing the research of peer editors, which could result in knowledge being published by editors with less consideration on the content and more consideration of the individual's membership to the editor party (Confessions, 2011). In each of the cases described, when examining researchers with Weber's (1946) conceptualization of political power in mind,

researchers with different access to political power and membership to parties appear to emerge. Further, this political power or party membership may provide researchers with benefits based on their goals and the goals of their parties. At the same time, just as Weber (1946) outlines that political power can be based on status and/or class, it appears each instance of political power and party membership among researchers overviewed in this chapter stems from their status.

Weber's (1946) theoretical framework for stratification in society has led to the identification of the resource divisions among researchers based on their unequal access to class, status, and political power. Moreover, it appears researchers may not simply have unequal access to these resources, but also that their divided access could lead to unequal outcomes for the labor each invests in knowledge production. Class divides among researchers were seen coming from their unequal access to funding and the infrastructure vital to their knowledge production efforts, which were documented as influencing the amount of research they produce, its quality, and whether it is finalized through publication (Blumenthal, Campbell, Causino, & Louis, 1996; Feldman & Florida, 2010; Godin & Gingras, 2000; Goldfarb, 2008). Status differences were also seen across researchers, and unequal outcomes were seen resulting from their status such as increases in the opportunities they have for research as, increases in the outcomes and rewards they receive (e.g., capital or references in other scientists' work), and increased dissemination and visibility of their research which can further enhance their status (Bjork & Solomon, 2012; Cole 1970; Garfield, 2006; Guedo, 2001; Merton, 1988; Saha, Saint, & Christakis, 2003; Tzarnas & Tzarnas, 2015). Unequal access to political power also appears to exist among researchers granting positive benefits such as the ability to increase their research output and get published based on parties that stem from their hierarchical positions in organizations, their participation in

institutional administrative activities, and their connections to scientific journals as editors (Bland et al., 2006; Blumenthal, Campbell, Causino, & Louis, 1996; Haak, 2002; Sellers-Rubio, Mas-Ruiz, & Casado-Diaz, 2010). However, this chapter also highlights the need for more thorough examinations of researchers in the United States through the lens of Weber's (1946) stratification theory. As a result, the next chapter in this paper takes the hypotheses formed in this chapter and the elements of Weber's (1946) stratification theory not found in the literature and attempts to answer these questions through the analysis of data. Specifically, the next chapter will examine if researchers' unequal access to class, status, and political power are related to the publication, dissemination, and success of their knowledge production efforts as this chapter theorizes. It will also consider whether Weber's (1946) theoretical link between technological innovation and increased class stratification holds true for researchers as their reliance on innovations such as infrastructure characterized by modern technologies and equipment increase. Additionally, the following chapter will build on the connections of researchers' status to their political power and examine whether they are truly linked as the review of literature in this chapter suggests, while also considering political power's connection to class since Weber (1946) indicates class and status have the potential to shape it.

CHAPTER 5

ANALYZING THE APPLICATION OF STRATIFICATION THEORY

So far, this paper has examined knowledge production in detail using theoretical frameworks devised by Marx (1844/1848/1867) and Weber (1946). The application of Marx's (1844/1848/1867) theories paints a picture of classes formed around the means of knowledge production, and poses questions about the exploitation and alienation that occurs between researchers and owners of the means. When applying Weber's (1946) theory of stratification to researchers in the United States, divisions based on class, status, and political power seem to form, and appear to fuel unequal outcomes in their knowledge production efforts. This chapter will further examine the validity of the application of Weber's (1946) theoretical framework to researchers in academia. Considering the vital importance of knowledge today in the United States and the amount that is produced in institutions of higher education, this applied analysis on the applicability of this stratification theory to researchers in academia will help paint a more informed picture of the divisions among researchers and any potential benefits, dangers, and solutions that may be associated with said divisions.

Hypotheses

In the previous chapter, the application of Weber's (1946) theory helped identify three main hypotheses that will be tested using statistical analysis in this chapter. Based on the divisions in class, status, and political power seen among researchers and the potential for unequal outcomes to stem from these divisions the main hypothesis that is examined in the chapter is: Researchers have different amounts of class, status, and political power that influence the outcomes of their research. Considering researchers' reliance on infrastructure characterized

by modern technologies and equipment documented in the literature the second hypothesis examined is: Researchers' reliance on technological innovations such as infrastructure lessens the influence of status and increases the effect of class on their stratification. Further, the potential connection of researchers' status to their political power noted in the literature has informed the last hypothesis: Researchers' class and status are related to their political power.

Sample

To test the hypotheses that emerge when applying Weber's (1946) theory of stratification to researchers, bibliometric data was obtained. Bibliometric data contains information concerning knowledge that has been produced and published in scientific journals and the amount of times each publication has been referenced by others in the scientific community. Many studies have undertaken the analysis of published knowledge via bibliometric data (Peterson, Jung, Yang, & Stanley, 2011; Subramanyam, 1983; Wan, Anyi, Anuar, & Zainab, 2009). Specifically, this data documents the names of research publications and other information about them including, but not limited to, the names of the authors, the institutions authors are affiliated with, and the number of times each publication has been referenced in the knowledge produced by others.

For this study, a sample of bibliometric data was obtained using nonrandom and random methods from Scopus, an online database that contains peer-reviewed scientific journals. Specifically, a multi-stage cluster sampling methodology was employed. Once Scopus was identified in the first stage of sampling due to its ability to provide data on the population of interest, academic researchers in the United States, the second stage involved retrieving two clusters of bibliometric data from the database. Both clusters obtained in the second stage

contain the 2,000 most referenced scientific journal publications produced in the United States since the year 2000 which were retrieved in Scopus when the keyword “science” was searched. One of the clusters is made up of the 2,000 most referenced natural science publications (e.g., physics, chemistry, math, medicine, etc.) that resulted when searching for this term, and the other is made up of the 2,000 most referenced social science publications (e.g., sociology, economics, arts and humanities, etc.). Although bibliometric data can be obtained from Scopus, it can only be retrieved for searches that are conducted on the database. Accordingly, the keyword “science” was used in an attempt to keep the search term neutral and obtain a diverse set of articles that closely represent the population of publications overall in the natural and social sciences. The top 2,000 referenced articles were obtained to ensure the sample that was selected had successfully produced referenced knowledge, as many scientific publications have never been cited, to allow for an analysis of researchers’ class, status, and political power and how they relate to the number of times their published knowledge has been cited (i.e., its success). Further, clusters consisting of natural and social science publications were obtained to ensure this analysis can speak to the application of Weber’s (1946) stratification theory for both types of scientists who produce knowledge. The third stage obtained two random samples of 50 academic journal publications. Since the two clusters contain research produced at the various sites of knowledge production in the United States, random selections were made from each cluster until 50 publications from academia were identified. This sampling methodology led to the identification of a sample of 100 academic peer-reviewed research publications, 50 from natural scientists and 50 from social scientists, produced in the United States since the year 2000.

Measures

In order to test the application of Weber's (1946) stratification theory, this analysis identified measures of class, status, political power, and research success. Since bibliometric data contains information on the number of times each publication is referenced it can indicate the various levels of impact and success researchers' publications had (Guedo, 2001; Tzarnas & Tzarnas, 2015). Accordingly, citation counts for each publication in the sample are interpreted as the unequal outcomes of each researcher's knowledge production efforts that may be affected by class, status, and political power. The number of times researchers' publications were cited ranged from about 200 to 1,600 which shows that despite all coming from the top 2,000 journal articles referenced, the publications in this sample have varying levels of success. Similarly, indicators of the divides among researchers identified in the literature in the previous chapter helped inform how class, status, and political power are measured in this analysis.

Since the literature reviewed in Chapter Four indicates that researchers have different class positions according to Weber (1946), based on the amounts of funding and quality of the infrastructure they have access to, the class of each researcher in the sample is coded based on the Carnegie classification of the research universities where they produced their knowledge (Blumenthal, Campbell, Causino, & Louis 1996; Goldfarb 2008). The class resources each researcher had access to during their knowledge production efforts is measured through this proxy because these classifications are associated with the research expenditures of universities (Jaschik, 2006). This measure of class was coded as an ordinal variable for the entire sample of 100 academic research publications. In total, 79 out of the 100 publications in the sample came

from the highest tier of Carnegie research universities which indicates high class positions for a majority of the publications considered.

To measure the amount of status researchers had while they produced the knowledge in this sample, two variables were coded that indicate status based on Weber's (1946) theory. The first status variable is the number of journal publications researchers had prior to producing the journal article in the sample. Considering the number of publications researchers had prior to the knowledge they published in this sample is based on Merton's (1988) findings which show status benefits increase for researchers based on their previous research efforts. This variable was based on counts of the number of prior publications for researchers listed in databases containing scientific publications such as Scopus. The number of previous publications researchers had ranged from 0 to 585 indicating a high degree of variation in this measure across the sample. The second status variable is the impact factor or rank of the journals each research article was published in, since studies show such measures shape the status of journals and can impact the amount of attention and success researchers experience from their publications in them (Guedo, 2011; Bjork & Solomon 2012). Since the initial bibliometric data obtained listed the scientific journals each article was published in, their names were used to uncover the impact factor of each which were inputted as numerical values. The journals that featured the publications in this sample were characterized by impact factors ranging from 0.3 to 12.11 which shows the publications in this sample were published in journals with various degrees of status. Both of these status variables are continuous and were collected for all 100 research publications in the sample.

To consider the amount of political power each researcher had access to when producing the knowledge in this sample, three variables were coded. Using the names of the researchers listed in the bibliometric data searches were conducted for each researcher's publicly available curriculum vita which were used to code variables for political power. The first measure coded for political power was an ordinal variable based on each researcher's appointment in academia. This variable is used to measure political power since Weber (1946) states that political power is often related to hierarchical structures and prior studies show researchers with higher appointments in academia produce more knowledge. The academic publications in this study came from a wide range of academic personnel, which included everything from graduate students to tenured professors. Since coding political power was based on finding researchers' public curricula vitae, data was only found regarding the academic appointments of 88 out of 100 researchers in the sample. The second measure used to indicate political power in this study is the number of administrative activities researchers were involved in (i.e., the number of governance activities they participated in, such as committees) when their knowledge was published. This measure was developed based on the administrative activities researchers listed in their curriculum vita since Weber's (1946) theory indicates political power is associated with the ability to influence policy, which is suggested by participation in these institutional governance activities. Further, this measure is informed by prior research that shows researchers' participation in governance activities are associated with increased amounts of knowledge production (Blumenthal, Campbell, Causino, & Louis, 1996; Sellers-Rubio, Mas-Ruiz, & Casado-Diaz, 2010). The number of administrative activities researchers in the sample participated in ranged from 0, with 52 out of 81 not participating in any, to 12. The third variable

coded to measure researchers' access to political power is based on the number of editorial activities for scientific journals in which their curriculum vita shows they participated during the time their research was published. This measure was chosen based on Weber's (1946) theory which states the ability to shape policy outcomes, which would include their enforcement to determine the worthiness of produced knowledge by journal editors, indicates political power, and findings that show participation in the editing of peer-reviewed scientific journals can provide benefits for researchers in their efforts of knowledge production (Confessions, 2011; Haak, 2002). The number of editorial activities researchers participated in ranged from 0 to 37 and only 26 out of 81 researchers were not considered journal editors while producing the knowledge in this study. Data for these two variables, number of administrative and editorial activities, were only collected for 81 out of 100 researchers in the sample due to difficulty finding 11 natural and 8 social scientists' curricula vitae.

Analysis

Once the sample was identified and data was collected for each variable of interest, chi-squared tests were performed to examine the sample further and assess the validity of the three hypotheses. The first hypothesis, researchers have different amounts of class, status, and political power that influence the outcomes of their research, was explored by carrying out six chi-squared tests. These tests were used to determine if the unequal outcomes of researchers' knowledge production efforts, indicated by the number of times their knowledge has been referenced, is related to the measures of class, status, and political power that were collected for each. Table 1 provides the results of these chi-squared tests. These tests did not identify any relationships between these variables and thus this hypothesis cannot be confirmed.

Table 1. Results for first hypothesis.

Chi-Squared Results for Relationships Between Citations and Class, Status, and Political Power			
Relationships Tested	Value	df	P-value
Citations and Class Measures:			
Research Tier	290.75	99	0.184
Citations and Status Measures:			
Prior Publications	5,300	99	0.552
Journal Impact Factor	7,000	99	0.252
Citations and Power Measures:			
Appointment Type	403.43	87	0.374
Admin Activities	446.18	80	0.462
Editorial Activities	1,400	80	0.267
* significant at $\alpha = 0.05$; ** significant at $\alpha = 0.01$; *** significant at $\alpha = 0.001$			

The results in Table 1 also speak to the second hypothesis that researchers' reliance on technological innovations such as infrastructure lessens the influence of status and increases the effect of class on their stratification. Since the results in Table 1 indicate that no relationship can be established between the unequal outcomes of researchers' knowledge production efforts and their class and status these findings show that neither class nor status influence the stratification of researchers more. Accordingly, Table 1 demonstrates the second hypothesis cannot be accepted.

To explore the legitimacy of the third hypothesis, researchers' class and status are related to their political power, nine additional chi-squared tests were carried out. The results of these tests are present in Table 2. Of the nine chi-squared tests performed, seven were found to be non-significant suggesting no relationship between class and/or status and political power. Two of the chi-squared tests did provide significant findings and indicate that relationships can be established between researchers' class and status and the extent of their editorial activities. The results of the chi-squared tests analyzing how researchers' class and status are related to their

political power present in Table 2 indicate the third hypothesis cannot be fully rejected or fully accepted.

Table 2. Results for second and third hypotheses.

Chi-Squared Results for Relationships Between Class/Status and Political Power			
Relationships Tested	Value	df	P-value
Class and Political Power:			
Research Tier and Admin Activities	21.75	80	0.243
Research Tier and Editorial Activities	110.31	80	0.000***
Research Tier and Appointment Type	7.73	87	0.934
Status and Political Power:			
Prior Publications and Admin Activities	302.746	80	0.542
Prior Publications and Editorial Activities	1,200	80	0.000***
Prior Publications and Appointment Type	264.25	87	0.587
Journal IF and Admin Activities	428.73	80	0.057
Journal IF and Editorial Activities	1,200	80	0.879
Journal IF and Appointment Type	371.82	87	0.259
* significant at $\alpha = 0.05$; ** significant at $\alpha = 0.01$; *** significant at $\alpha = 0.001$			

Although the review of the literature in Chapters Three and Four does not indicate how the class, status, and political power of natural and social scientist may be different, seven chi-squared tests were conducted to examine how different types of scientists compared across these measures. Table 3 contains the findings of the tests comparing natural and social science researchers' access to class, status and political power. These results show that the number of citations and status researchers have are not significantly related to the type of research (e.g., natural or social) they conduct. However, these findings indicate that the class and political power of researchers may be related to the type of research they conduct.

Table 3. Additional findings.

Chi-Squared Results for Natural and Social Scientists Comparisons			
Comparisons Tested	Value	df	P-value
Outcomes:			
Citations	98	99	0.265
Class Measures:			
Research Tier	8.09	99	0.044*
Status Measures:			
Prior Publications	63.56	99	0.319
Journal Impact Factor	92.57	99	0.109
Political Power Measures:			
Appointment Type	10.59	87	0.060
Admin Activities	20.95	80	0.002**
Editorial Activities	32.36	80	0.028*
* significant at $\alpha = 0.05$; ** significant at $\alpha = 0.01$; *** significant at $\alpha = 0.001$			

Discussion

Even though the analyses conducted in the paper did not confirm many significant relationships exist between the variables of interest, they still provide additional insight into researchers and their knowledge production efforts in the United States. The results of the chi-squared tests for the first hypothesis (Table 1) indicate that no relationship can be identified between the measures of class, status, and political power used in this study and the number of times the knowledge produced by researchers was referenced by others (i.e., the extent of its success). This means the first hypothesis cannot be confirmed and contrary to Weber's (1946) theory, the resource divisions among researchers in this sample do not appear to be related to the unequal amounts of success each obtained for their efforts. The findings in Table 1 and the rejection of the main hypothesis in this paper also go against the findings of the literature reviewed in Chapter Four which indicated class, status, and political power have the potential to

influence research outcomes. The results of the chi-squared tests in Table 1 also speak to the second hypothesis that increasing technological requirements of knowledge production lead to more stratification based on class rather than status. Since the findings in Table 1 show that no relationship can be identified between researchers' class, status, political power, and their articles' unequal citation counts, this analysis indicates there is no difference in the effect status or class has on stratification, as neither appear to have any effect on it. The inability of this analysis to confirm the second hypothesis goes against Weber's (1946) theory of stratification and his claims that technological innovations reduce the influence of status but increase the effect of class on stratification.

The results for the third hypothesis (Table 2), researchers' class and status are related to their political power, indicate that this hypothesis cannot be fully accepted or rejected. Table 2 shows that class and status divisions among researchers do not heavily shape the amounts of political power they have. Specifically, class and status do not appear to be related to the measures of political power that focus on researchers' academic positions and the number of administrative activities in which they participate. However, researchers' political power measured by their participation in scientific journal editing is impacted by their class positions and the status they garner from prior publications based on the findings in Table 2. The results do not fully challenge or support Weber's (1946) claims that divisions in class and/or status across society shape the political power individuals' have access to. Finding no relationship between researchers' class and their hierarchical position and administrative activities is not surprising since the literature did not indicate a relationship between these variables, but the significant relationship between researchers' class and their editorial activities is worth noting since the

literature gave no indication that their class can fuel their political power. The fact that the one type of political power, derived from participation in journal editing, was found to be influenced by status (Table 2) supports the findings of the literature review in Chapter Four which highlighted that researchers who edit journals are often those that have garnered status within their fields of study (Haak, 2012). However, it appears Haak's (2012) findings cannot be generalized to indicate researchers' status influences other types of potential political power such as their hierarchical positions or their participation in administrative activities.

Although the review of the literature in Chapter Four provided no basis to make hypotheses about the differences between natural and social scientists' access to class, status, and political power they were analyzed in this study to gain a better understanding of the divisions that exist among academic researchers involved in knowledge production in the United States. The results in Table 3 shows the results of this analysis and the extent to which the success of researchers' knowledge production efforts, as well as their class, status, and political power may be shaped by whether they are natural or social scientists. On the one hand, these results show no significant relationship between the amount of success, or citations, researchers' publications had and the type of researcher (e.g., natural or social) they are. Similarly, researchers' status, measured by their prior publications and the status of the journals in which they published their knowledge, is not related to the type of research they conduct (Table 3). This shows the number of times research in this sample is cited, the impact factors of the journals it was published in, and the number or prior publications researchers had were not significantly different when considering whether the knowledge was produced by a natural or social scientist. On the other hand, the results in Table 3 indicate that the class of researchers is significantly related to

whether they are natural or social scientists. Considering 44 social scientists and 35 natural scientists came from the highest level of Carnegie research university and this sample represents researchers with publications among the 2,000 top referenced natural and social science articles, the results in Table 3 may indicate that social scientists need higher class positions in order to have publications as successful, or with as many citations, as natural scientists. The findings in Table 3 also speak to the differences in natural and social scientists' interactions with political power. Although researchers' political power measured by their position in the academic hierarchy is not related to the type of knowledge they produce, their political power measured by their participation in administrative and editorial activities does depend on whether they are natural or social scientists. Considering that more social scientists participate in administrative activities in the sample overall, it appears the findings in Table 3 suggest they have higher levels of political power stemming from this measure. Similarly, natural scientists in the sample participate in more editorial activities and thus the significant relationship between editorial activities and type of researcher shows that such activities shape to the political power of natural scientists.

Overall, the results of the analyses in the study were unable to confirm the three main hypotheses forged by the literature review in Chapter Four. However, interesting differences in natural and social scientists' access to class and status were observed. Although it may be easy to interpret this study's inability to confirm any of its hypothesis as evidence that Weber's (1946) theory of stratification is not applicable to academic researchers in the United States, there are many other explanations that should be considered and further explored first. One possible explanation of the results in Table 1 and Table 2 and the lack of relationships they identified

between the number of times publications were referenced and the class, status, and political power of their authors, could indicate that the sample is not representative of the population it was collected to study. The nonrandom purposive selection of publications that characterized a large portion of the sampling methodology along with the small size could have biased the sample and subsequently the results of this study. One potential example of sampling bias can be seen in the lack of diversity across the sample for the measure of class used which most likely stemmed from the small sample size and the focus of the sample of the top 2,000 most referenced publications. Other sampling issues in this study stem from the data missing for the political power variables for several researchers which restricted the amount of data available and dropped the sample below 100 for the analyses involving these variables. Another possible explanation of the findings of this study is that the proxy measures used in this analysis were not appropriate to gauge the concepts of interest in this study. Although the selection of proxy measures used in this study were validated at face value based on Weber's (1946) theory and the literature review in Chapter Four, it is possible they do not truly represent measures of unequal knowledge production outcomes and researchers' access to class, status, and political power. In the end, it is important to consider these potential shortcomings and to ensure they are taken into consideration by future research to help ameliorate any methodological problems that may have existed in this study.

CHAPTER 6

CONCLUSION

Knowledge is important to several aspects of society. Additionally, due to the United States' increased reliance on knowledge in the twenty-first century, it is considered a knowledge based society (Campbell, 2006). In the United States, knowledge is produced in certain settings (e.g., research universities, industry and government laboratories, independent research institutes, etc.) across the nation (Godin & Gingras, 2000). For researchers to produce knowledge and distribute it they must have access to the appropriate resources (e.g., laboratories, funds, the ability to publish, etc.) (Feldman & Florida 1994). During of the Industrial Revolution, Karl Marx developed theoretical frameworks to analyze capitalism including the production processes it was based on. Accordingly, this paper analyzed the production and distribution of knowledge through the theoretical lenses of Karl Marx and Max Weber.

The theoretical framework Marx (1844/1848/1867) used to analyze capitalist production and distribution was used in Chapter Three to illuminate the resources or means that are important in knowledge production and knowledge distribution, the parties involved in these processes, and whether conflict exists between the parties involved. The analysis uncovered that knowledge production relies on access to three essential means of knowledge production which are an appropriate infrastructure, funding, and the ability to publish. Additionally, it illuminated that owners who possess the means of knowledge production and researchers who do not can be identified using Marx's (1848) framework. The social positions of these classes also appear to be determined by their ownership and access to the means of production, as researchers are put in subordinate roles to the owners because they need to access the means. Additionally, according

to Marx (1844), the lack of control researchers have over the means of production and subsequently the types of knowledge they develop may result in them being exploited or alienated during the production process. However, this analysis also underscores the need for future and more thorough examinations of the production and distribution of knowledge in the twenty-first century using Marx. Future investigation should attempt to uncover any additional means of knowledge production, examine whether researchers are exploited or not in their subordinate relationships to the owners of the means, and build on the findings of this theoretical analysis and Miller's (1967) study which suggests researchers may be alienated during their knowledge production efforts.

The theoretical framework Weber (1946) devised to understand stratification was applied to knowledge production in Chapter Four to determine if resource divides exist among researchers and, if so, do the divides lead to unequal returns for them during their knowledge production efforts. Weber's (1946) framework led to the identification of the resource divisions among researchers based on their unequal access to class, status, and political power. It also showed the divides among researchers' access to class, status, and political power can lead to unequal outcomes in their knowledge production efforts. However, chapter four highlighted the need for more thorough examinations of researchers in the United States through the lens of Weber's (1946) stratification theory. Accordingly, chapter five took the hypotheses formed in chapter four and elements of Weber's (1946) stratification theory that the literature review did not shed light on and tried to explore them further through data analysis. Specifically, chapter five examined whether researchers have different amounts of class, status, and political power that influence the outcomes of their research; if researchers' reliance on technological

innovations such as infrastructure lessens the influence of status and increases the effect of class on their stratification; and if researchers class and status are related to their political power.

Ultimately, the results of the analyses carried out in Chapter Five could not confirm the three main hypotheses forged by Weber (1946) and the literature reviewed in chapter four. However, interesting differences in natural and social scientists' access to class and status were observed. Future studies should further examine the applicability of Weber's (1946) stratification theory to researchers in the United States while taking the potential methodological shortcomings of this study into account. Specifically, these studies should attempt to employ larger samples that are randomly collected and represent the population of interest, and have better means for collecting data to ensure less data is missing to avoid sampling biases. Such studies should also consider additional measures that can be used to indicate class, status, and political power and ensure the measures they use can be validated to avoid the potential for measurement biases. Additionally, future studies should explore other methods of analysis, beyond chi-squared tests, that can delve further into the relationships between the divisions in class, status, and political power among researchers and the unequal outcomes of their knowledge production efforts.

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BIOGRAPHICAL SKETCH

Ryan Dorman graduated with his Master's in Applied Sociology from The University of Texas at Dallas in 2017. He is a member of the Phi Kappa Phi national honors society. His research interests include social stratification, economic sociology, education, the sociology of knowledge and technology, and alcohol and drug prevention. As a graduate student, he worked for UTD as a sponsored graduate assistant in the provost's office under assistant provost Serenity King assisting with the university's reaccreditation. He also attended UTD as an undergraduate and graduated summa cum laude in 2015 with a Bachelor of Arts in Sociology. As an undergraduate he worked with Dr. Carol Lanham writing literature reviews, and worked as a paid research assistant under Dr. Meghna Sabharwal writing literature reviews and coding qualitative data.

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Areas of Research Interest

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Presentations

2015 – Southern Sociological Society meeting, New Orleans, LA

Panel discussion, “Development of a School-Based Drug Prevention Program for Homeless Youth: Challenges and Opportunities.”

2016 – Southern Sociological Society meeting, Atlanta, GA

Poster presentation, “Is Love Blind Online? An Investigation of Homophily in Online Dating.”

Research Involvement

October 2015 – Present

Graduate assistant in The University of Texas at Dallas provost’s office under assistant provost Serenity King assisting with research relevant to the university’s reaccreditation. Helps collect, translate and analyze qualitative data, performs literature reviews, performs research on intuitional policies, and writes regular reports and papers regarding findings of such investigations.

December 2015 – August 2015

Research assistant for Dr. Sabharwal at The University of Texas at Dallas. Helped with NSF funded research focused on migration patterns of high skilled scientists and engineers. Translated and analyzed qualitative data, performed literature reviews, and wrote regular reports and papers regarding findings.

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Part of research team headed by Dr. Cirulli Lanham at The University of Texas at Dallas and working with the Dallas non-profit Focus on Teens. Team assessed effective ways to prevent substance use among at-risk adolescents that attend Dallas high schools. Went through IRB process, conducted extensive literature reviews, and proposed effective means for substance abuse prevention in Dallas high schools to Focus on Teens. Awaiting results of current program implementation in four Dallas high schools to assess results of substance abuse prevention program used.

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