Understanding the Function of a Science, Technology, Engineering and Mathematics Master's Degree

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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GENERAL RESEARCH PROBLEM AND CONTEXT

Throughout the 1900's, administrators, legislators, and educators debated the purpose of higher education, with two warring factions principly defined by their view of the underlying function of a degree. The first group were those in favor of a liberal arts education, curriculum that endorsed a holistic approach to course offerings providing students with a well rounded understanding of citizenship and life. The second group was comprised of individuals who believed in the value of specialized degrees, often more applicable to the eventual career path students pursue post graduation. While institutions at the time often opted for the specific path best suited for their students based on their resources, in 1967, Ronald Reagan's approach to education radically shifted American's public perception of what it means to attend college. With his staunch disregard for "intellectual luxuries," course work and curriculum promoted by liberal education, Reagan's stance shifted the American motivation for higher education toward potential future earnings and away from the ideals of a diversified curriculum (The Chronicle of Higher Education, 2015).

While the purpose of American higher education may have shifted, this paper aims to develop an understanding of the current state behind motivations for advanced degrees in the science, technology, engineering and mathematics (STEM) field and to determine how these degrees function within the greater workforce. While doctorate degrees have primarily represented the essential gateway to become an educator within the higher education field, Master's degrees represent a middle ground in which the exit options remain far more ambiguous and the purpose much more fluid. In order to answer this question, this report uses several frameworks, perspectives, and stakeholders to generate a

stance on how these STEM Master's degrees function for students, and identify an underlying position on their value, both economically and holistically.

FRAMEWORKS AND LIMITATIONS

Frameworks

In the attempt to characterize the complex functionality of STEM Master's degrees, I have taken note of the distinct social groups in an effort to demonstrate how advanced education provides differing value and meaning to specific groups of people. As Bijker, Hughes and Pinch explain, "The phrase [social group] is used to denote institutions and organizations (such as the military or some specific industrial company), as well as organized or unorganized groups of individuals. The key requirement is that all members of a certain social group share the same set of meanings, attached to a specific artifact" (Bijker, Hughes and Pinch, 2012, Page 23). While the artifact discussed here is less a physical technology and instead, a program, curriculum, or diploma, the ideology and relationship still represents a key framework in this paper in drawing conclusions to the research problem. While the standard functionality of a Master's degree for a white male may represent a key stepping stone towards greater career success, this may not be the case for alternative social groups, and are discussed as such in order to account for this difference in experience. In the process of researching and developing a stance on the landscape of Master's degrees and higher education as a whole, the gender complexities and racial dynamics that effect these degrees, institutions, and outcomes became unavoidably tied to the educational experience itself, and therefore, necessitates this perspective.

Limitations

There are several limitations or caveats to my research to consider in order to draw appropriate conclusions. Throughout this report, STEM is defined as Science, Technology, Engineering and Mathematics with the distinct inclusion of all natural sciences under the science descriptor. That said, the medical field and health sciences field are considered in several of the statistics, particularly those discussing the involvement and participation of women. This can be considered a more encompassing view of the STEM field, however, it is recognized that those may not be considered within the domain of the STEM field in all instances.

Similarly, this paper relies heavily on statistics and the shortcomings of this approach merit appropriate discussion. As Theodore Porter explains, "The norms of scientific communication presuppose that nature does not speak unambiguously, and that knowledge isn't knowledge unless it has been authorized by disciplinary specialists. A scientific truth has little standing until it becomes a collective product" (Porter, 1995 , Page 12). While we see the way in which we evaluate these outcomes for Master's degree graduates as scientific, much like the ranking of colleges, these too may be subject to bias. Even if society acknowledges that these are the correct metric for defining career and educational success, it must acknowledge that this is simply one determinant of the value of education and advanced degrees.

Lastly, the conclusions and expressions of experiences of those within the field should not be considered all encompassing, as the motivations and experiences can be highly personalized and contrary to those stated.

THEORETICAL DISCUSSION

Following the 1960's, the debate around the purpose of a degree still remains in contention. Participation in traditional disciplines like the natural sciences and mathematics have decreased, while there has been an increase in niche, career oriented programs in business or media (Selingo, 2015). With total American student loan debt hitting 1.7 trillion in September of 2022, students have naturally turned their focus on completely major programs with a natural progression to high paying jobs (Council on Foreign Relations, 2022). This contention inherently lends itself to discussion around how the population should think about higher education as a whole, and the subsequent value of a degree at any level of higher education.

Education and Degree Signaling

Much of the debate around the value of advanced degrees surrounds the notion of signaling. The degree or education signaling theory states that instead of providing valuable skills that will translate to a high degree of utilization in the workplace, a degree simply signals to potential employers and the greater workforce that you are able to navigate the collegiate environment and demonstrate follow through and ambition. Furthermore, the institution from which a degree comes from creates a hierarchy of applicants, those with top tier degrees signaling a greater extent of potential ability while those with less renowned degrees signal accordingly (Carlson, 2019).

The impact of a degree on employement, however, reflects another interesting conundrum within higher education. According to Pew research center, while 44% of people with an associate degree have stated that they have decided not to pursue a job due to a bachelors degree being listed as a credential, the percent of people who believe that their education was primarily around personal growth increases with more advanced degrees. The percent of individuals who believe that their education was focused on personal development is 31% for those holding an associate degree, 41% for those with a bachelors degree, and 47% for those who have obtained a postgraduate degree. Inversely, the percent of people believing their education revolved around gaining marketable skills was 54%, 44%, and 35% for those same degrees, respectively (Pew, 2016). While a degree requirement for job applications remains a deterrent for many within the labor market, advanced degrees seem to increase the likelihood of using education as a holistic approach to self improvement.

College Admissions Scandal

While Master's degrees were not included in the comprehensive reports on the 2019 college admissions scandal, the story merits discussion as it provides commentary on American sentiment towards higher education and the value of a degree. The scandal, which involved the bribery of several university coaches and administrators, changed the narrative around how the wealthy elite of America interact and influence our most prestigious institutions (Korn, 2023). Along similar lines of education signaling, while the students attending these elite universities would likely not utilize the value of their education to the full extent, parent's willingness to commit crimes to earn their child an unfair entrance to these schools speaks to America's newfound obsession with the face value of degrees. Just

as these parents were likely fascinated with their child obtaining these degrees, if it is only the degree they are interested in, what does that mean for advanced degrees?

In regard to the college admission scandal, however, it should be noted that the impact on discipline and degree resided primarily in certain schools. While the story speaks volumes about America's changing perspective on higher education, the function of the education for these students may not be representative for all undergraduate or postgraduate students in America. Though their admission to these institutions made headlines, there is little spoken of their associated time at these schools, and therefore, it is difficult to extrapolate whether this infamous incident lends greater understsanding to anything more than the growing obsession with pedigree among the American elite.

Ranking

One major catalyst for how America values higher education spawns from the US News and World Report Ranking system. However this system has already demonstrated a major flaw in how the population evaluates college pedigree. As Cathy O'Neill explains in her book, *Weapons of Math Destruction*, the US News and World Report developed their ranking system with the explicit goal of providing Americans with a complete understanding of their available college options. Over time, the rankings became a feedback system in which institutional spending correlated to metrics that would increase their rank, rather than the actual value of the education provided to students. As O'Neill states:

> "U.S. News's first data-driven ranking came out in 1988, and the results seemed sensible. However, as the ranking grew into a national standard, a vicious feedback loop materialized. The trouble was that the rankings were self-reinforcing. If a college fared badly in U.S. News, its reputation would suffer, and conditions would deteriorate" (O'Neill, 2016, Page 56).

Under these conditions, higher education institutions transferred their resource allocation strategies to target their ranking, rather than improve internal metrics aligned with their school's values and goals.

In March of 2022, US News and World Report published their rankings on the best engineering graduate schools, and although progress was made, the system itself is still far from perfect. While the news outlet has made great strides in an effort to align assessment metrics to the greater value, according to the US News and World report website:

> "an advanced degree in engineering can help students improve their proficiency, specialize in fields of interest, take advantage of leadership opportunities and eventually earn higher salaries. To assist in discovering the programs that may be the best fit, U.S. News' Best Engineering Schools rankings compare schools on their research activity, faculty resources, academic achievements of entering students and assessments by other engineering schools and employers" (US News and World Report, 2022).

While the mission statement recognizes the importance of post-graduate employment performance, the comprehensive value of the education remains somewhat underrepresented. While this may be a symptom of the current American motivation for higher education, American understanding and interest in advanced degrees is in many ways tied to these metrics and ranking outlined by the news organization. Similarly, employers view these rankings as a determinant of the value of degrees

achieved, promoting the system in which the institution that issues a degree often matters more than the education received itself. While designed to provide insight into the importance and relative strengths of different universities and colleges, the task of condensing a process underpinned by personal preference into a universal ranked list is extremely difficult, and some may even argue, impossible.

EDUCATION AND EMPLOYMENT

The State of Master's Degrees in America

While some Master's degrees in America prove to be an essential step in the progression of a successful career, other's fall by the wayside. While Master's in Business Administration (MBA), the long believed critical part of a great career in finance or business, has seen a declining number of applicants, other master's and postgraduate degrees have still seen growth (Byrne, 2019). While the lion's share of master's degrees conferred remain as MBAs (24% in 2018), computer science has seen a massive increase going from 8% in the 1970's to 12% in the late 2010's (USAFacts, 2018). With median earnings for masters degrees sitting at approximately $78,000 per year compared to around $65,000 for those holding a bachelor's degree, the approximate pay off relates to a $13,000 dollar differential per year (Stobierski, 2020). However, with the rising cost of education and the increase in specialized programs, the value students receive may eventually be much more difficult to determine. Even as certain sciences top the charts for greatest differential between Master's and Bachelor's degree earnings,

those fields are predominantly healthcare related professions where a Master's and eventually a doctorate are considered standard and essential.

As a Master's in Biology or nursing corresponds to 87% and 44% increase in median earnings, respectively, much of the biggest differentials are in other disciplines outside of the STEM domain such as the famed MBA. While computer science and statistics, representing a median earnings increase of 32% and 19%, the large portion of the natural sciences, the STEM domain seeing a decrease in participation in Master's programs, fail to make the list of highest earning differentials (Hess, 2021). As STEM becomes increasingly more important in a technology driven world, the current state of advanced education speaks to a decreasing value in the core, traditional sciences.

Female Representation

In 2018, more than 730,000 postsecondary degrees were conferred in the United States in STEM disciplines, representing an approximate 54% increase since the early 1970's. However, of those 730,000, only about 238,000 or 32% were granted to women. While the proportion of women receiving these degrees represents a 66% increase during the same time frame, women remain disproportionately underrepresented as participants and recipients of postsecondary degrees (USAFacts, 2018).

The participation of women in the STEM space has been long discussed and analyzed. While programs designed to promote early engagement and an increased awareness of the distinct difficulties women may face entering the field have increased participation, the reason why women are underrepresented in STEM is often misunderstood. Contrary to popular belief, overall, women

represent approximately 50% of the STEM workforce. However, women are overrepresented in certain STEM fields, effectively balancing the sub-fields where they are underrepresented (Funk and Parker, 2018).

Women are primarily overrepresented in the healthcare sub-industry, while they are underrepresented in the highest growing sub-industries, such as engineering and computer science related work. Despite the efforts to promote women to get involved in highly technical fields and disciplines, since 1990, female representation in jobs in computer science, software development, and similar computer related employment opportunities has decreased by 7%, while this specific field has seen job growth of 338% during the same time frame (Funk and Parker, 2018).

While healthcare related jobs often see a large pay increase with the acquisition of an advanced degree, the function of a Master's degree can differ for women involved in other parts of the STEM field. While health adjacent majors see a massive pay increase between their Bachelor's degree and Master's degree, with those interested in biology and nursing seeing a 87% and 44% jump in pay respectively, the field itself is categorized by a need to obtain higher education (Hess, 2021). In an industry where many individuals have received advanced degrees or completed medical school, earning a Master's degree is in many ways a requirement. This often overshadows the difficulty women can experience in other STEM fields, those whose statistics are often crowded out by the volume of women in the health field. As Persis Yu of the Student Loan Borrower Assistance Project explained, "because of the way that the labor market is set up, women, people of color, and then especially women of color, really need to get that credential in order to compete in the labor market" (Hess, 2021). As such,

STEM Master's represent an opportunity to increase the likelihood of standing out in a labor market that is far from equitable.

Racial Diversity

While less often discussed, the racial makeup of the STEM, and more specifically STEM Master's and advanced degree, landscape paints a complicated picture. According to a study done by the PEW research center, the engineering and science fields were ranked as two of the least open professions towards black people. Even more interestingly, the percent of black adults who felt welcome in these fields actually decreased between those holding a college degree and those with an advanced or postgraduate degree. While 21% of black adults with a college degree stated they saw engineering as welcoming, only 11% of black adults with advanced degrees saw the field as very open for individuals like themselves (Funk, 2022). This trend was similarly reflected in and among scientists and medical doctors, demonstrating a potential disparity between the opportunities for minorities in highly advanced and technical industries. Similarly, as of 2018, Black and Hispanic Americans were greatly underrepresented within the STEM workforce, accounting for only 9% and 7% respectively (Funk, 2018).

Similarly, within the education system, racial minorities are often at a further disadvantage over the course of completing a degree in the STEM field. In their research, Catherine Riegle-Crumb, Barbara King, Yasmiyn Irizarry note that:

> "Regarding departures via switching majors, we note that STEM is the only field where Black and Latina/o youth are significantly more likely than their White peers to switch and earn a

> degree in another field. For Latina/o students, this difference is explained by social class background; however, for Black students, this disparity remains pronounced and significant even after accounting for the differences in high school academic preparation" (Riegle-Crumb, King, & Irizarry, 2019).

These differences in education may not only contribute to minority presence and participation within undergraduate study, but the systemic factors leading to discouragement may have an influence on secondary degree involvement and eventual career outcomes within the related fields. As such, the structure of STEM education seems contradictory for many racial minorities, as there is apparent increased emphasis on degree and education status yet to complete those degrees is a vastly different process compared to their white counterparts.

CONCLUSION AND IMPLICATIONS FOR THE FUTURE

In conclusion, it has become apparent that Master's degrees, while not necessarily for all, represent a key stage of progression for those looking to advance their careers. Along with the salary increase, Master's programs in STEM often provide technical training in fields that require a high proficiency and ability. While health-related fields tend to require more advanced degrees, which offsets the female underrrepresentation in the traditional sciences, the growing technology industry represents an additional need for advanced education. Furthermore, these Master's degrees can act as equalizers to counteract the detrimental effects of a biased employment application process. Both undergraduate and postgraduate programs have moved away from a holistic approach to education, and the degree has

now become the principal signal to the workforce of an ability to succeed and add value to an employer.

In looking towards the future, the increasing presence of artificial intelligence, machine learning, and automation prompts a growing need for highly skilled workers. While this skill development may come at hands of employers in the form of on the job training or generalized training programs, higher education has and will continue to further become an effective area for companies to target impressive candidates, and advanced degrees may become a barrier to entry for those without the economic ability to postpone work for the one to two years it takes to obtain the degree. While traditionally it is believed that artificial intelligence will mainly disrupt the labor force in unskilled, mundane tasks, this may not be the case forever. While the current state of artificial intelligence is considered narrow, only operating at a high level of capability within a certain set of tasks, as that array of abilities widens, the world may see an unprecedented shift in the need for skilled workers. As explained in a White House report:

> "An emerging body of research suggests that AI can outperform workers in an increasing set of complex tasks mainly done by educated workers. Compared with earlier digital innovations, this suggests a paradigm shift in our thinking about AI's potential to automate worker tasks. For example, the automation of worker tasks by AI could exacerbate a process of occupational deskilling instead of job polarization" (White House, 2022).

Even though the future of employment remains unknown and highly complex, the threats to the education system, and the value of the education itself, should be on the forefront of higher education

administrators consideration as they architect the growth strategy for their respective institutions in the coming years.

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