Maggie Walker Governor's School– Team #4892,
Richmond, Virginia
Coach: Dickson Benesh
Students: Anant Kharkar, Will Overman, Pranay Vissa,
Wilton Wu, Alan Zhang

M3 Challenge Fifth Place Team, Exemplary Team Prize: $5,000

Moody's Mega Math Challenge
Executive Summary

Dear Administrators,

From 2000 to 2010, growth in the fields of Science, Technology, Engineering, and Mathematics (STEM) has tripled the amount of growth in non-STEM-related fields according to a 2014 report from the U.S. Department of Commerce Economics and Statistics Administration, and employment in STEM-related fields is projected to grow by more than 9 million by 2022 according to the U.S. Bureau of Labor Statistics. Thus, STEM jobs are in demand.

We have three models that students in your jurisdiction can use. First, Model 1 determines the cost of an undergraduate degree. We concluded that, all things considered, students can reasonably expect to pay the Expected Family Contribution, as defined by the government, for their education. Their final cost will be reduced only if total scholarships exceed the financial need as determined by the institution. A limitation of the model is loss of accuracy when dealing with unusual circumstances or students who are not dependents. Otherwise, the Expected Family Contribution part of the FAFSA has been in place since 1965 and has proven useful for families.

We really encourage students to use Model 2 because we believe it highlights something that may not be known in the educational system today. Our results show that a four-year STEM degree is the best economic decision. Therefore, by taking advantage of our model, your students can be motivated to pursue a career in STEM, not simply because you may want them to, but because mathematically it will prove to be a shrewd decision. But the most important conclusion from this model is that after a four-year STEM degree, the next best degree to pursue is in fact an Associate's degree. Our graphs show that it will prove to be a better economic decision than a four-year non-STEM degree in 30 years.

Ultimately, the final indicator of a student's best educational choice relies on personal preference. Therefore, Model 3 is a wonderful way to apply student opinions to the factors that entail a rewarding job. Our third model should be used because it requires a simple survey by the student. It will be analyzed with extensive data taken from actual employees who are engaged in the very careers that your students wish to pursue. Model 3 provides a simple four-option ranking system. If a student chooses to pursue a four-year STEM degree, Model 3 gives them the flexibility to choose whichever field they want, without the pressure of choosing only theoretical physics or pure biology. The drawback for this model is that we use survey data, which may not necessarily be accurate. In addition, students may not be wholly convinced by the simple model, which relies on such fluctuating survey data.

On balance, we truly believe that our models, with their ease of access, would greatly benefit the students in your school district. We hope you take into consideration our suggestions.

Wishing your students the brightest of futures,
M3 Challenge Team 4892

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1. Introduction

The United States has always been at the forefront of innovation and development, but a continued investment in lucrative fields—mainly those in Science, Technology, Engineering, or Mathematics (STEM)—is necessary in order to maintain this position. From 2000 to 2010, the amount of growth in STEM-related fields has tripled the amount of growth in non-STEM-related fields according to a 2014 report from the U.S. Department of Commerce Economics and Statistics Administration, and employment in STEM-related fields is projected to grow more than 9 million between 2012 and 2022 according to the U.S. Bureau of Labor Statistics. However, many of these fields require years of education, training, and experience; a college education is almost an informal prerequisite. Over the past 30 years, just tuition and fees for public four-year colleges, public two-year colleges, and private four-year colleges have increased by 225%, 150%, and 146%, respectively (College Board). The recent economic downturn and high records of unemployment for recent college graduates have also led many to question the value of higher-level education.

Answering the question of whether or not to attend college is not as easy as it seems. In order to assist students, federal and constitutional financial aid has helped offset the actual cost of college, but this process varies case by case. Additionally, one must not only take into account the cost of college, but also the specific major that one pursues. Factors such as earning potential, financial stability, and intangible benefits must be considered when deciding majors and fields.

1.1 Restatement of Problem

The cost of college at the undergraduate level has risen substantially over the past few years. At the same time, the demand for workers in the STEM-related fields has increased. Many high school graduates must decide which fields of education to pursue in college as well as what educational routes to take. In order to better understand the risks and benefits of each career path and to compare each route, we created mathematical models for each of the following problems:

1. Calculate an accurate estimate of a high school student's cost of attending college. In particular, examine the following combination options:
    a. A single-parent, one-child household or a two-parent, three-child household.
    b. Annual income of $35,000, $75,000, or $125,000.
    c. The risks/benefits of community college and President Obama's new plan.
2. Predict the earning potential and financial stability of graduates from STEM and non-STEM backgrounds.
3. Combine quantitative and qualitative factors to rank the education paths of high school students to allow them to make informed decisions about their career plans.

2. Model 1 (EFC Calculator)

2.1 Problem Analysis

College is very expensive. Millions of students each year seek out financial aid offers, corporate scholarships, and sometimes even odd secret family funds, but at the end of this long and arduous process, families have only one question on their mind: How much do I need to pay per year? Colleges have a sticker price which is constant for everybody, but the actual cost an individual pays depends on a variety of factors. Thus, it is important to find a way to calculate an undergraduate price that is unique to the individual. Our model focuses on an existing, nationally accepted method for determining the actual cost of college.

The Federal Application for Federal Student Aid (FAFSA) is commonly used across the vast majority of financial aid offices around the country. Although some universities may have different requirements or different protocols, the method utilized in the FAFSA document has been proven as a reliable indicator of financial need for the individual. For our model, we chose to focus on one specific element of the FAFSA document: the Expected Family Contribution (EFC). The EFC is calculated using a variety of factors not limited to total income, taxes paid, and family status.

However, the EFC is not the universal cost of college attendance. Not all colleges are able to meet 100% of demonstrated need. The final cost of attendance will differ based on the specific college which the individual chooses to attend.

2.2 Assumptions

1. To calculate the EFC, we assume that the household scenario (annual income, number of parents, and number of children) will remain constant over all the years the student is enrolled in college. In addition, there are no unusual household scenarios which may drastically affect the EFC to the overall college expense.
2. For the State Allowance value to calculate EFC, we used Virginia values because our salary and cost of living data are tailored for Virginia residents.
3. Students are dependents and do not earn any significant additional income.
4. Colleges are obliged to disclose the percentage of demonstrated financial need that they meet.
5. One student is being sent to college at a time from any household with more than one child.

2.3 Design

The EFC was estimated for each scenario using the official EFC formula guide Worksheet A from the FAFSA.gov website. The first step in calculating the EFC is to determine five different variables which are based on predetermined values and total income. The Total Income (I_{total}) is given. The five variables are Income Tax Paid (ITP), State Allowance (A_s), Social Security Allowance (A_{ss}), Employment Expense Allowance (A_{ee}), and Income Protection

Allowance (A_{ip}). ITP is calculated progressively using a household's Total Income and the predetermined IRS 2015 tax brackets, which are described in the chart below:

Tax Rate	Single Filers	Married Filing Jointly
10%	Up to $9,225	Up to $18,450
15%	$9,225 to $37,450	$18,451 to $74,900
25%	$37,451 to $90,750	$74,901 to $151,200
28%	$90,751 to $189,300	$151,201 to $230,450

A_s is equal to (I_{total})*(5%). A_{ss} can be calculated in two ways: if I_{total} is less than $133,700, the A_{ss} is equal to (I_{total})*(7.65%); if I_{total} is greater than $133,700, the A_{ss} is equal to $8,698.05 + [($I_{total \text{ over } \$113,700}$)*(1.45%)]. A_{ee} is equal to Total Income with a maximum of ($4,000)*(35%). A_{ip} is predetermined. In this case, for a household size of two (one parent, one child), the A_{ip} is equal to $17,440. For a household size of five (two parents, three children), the A_{ip} is equal to $31,650.

Next, the Total Allowance (A_{total}) is determined by obtaining the sum of ITP, A_s, A_{ss}, A_{ee}, and A_{ip}. Then, the Available Income ($I_{available}$) is obtained from the difference between the Total Income and (A_{total}). Finally, the EFC is calculated as shown by the chart below, obtained from FAFSA.gov website:

Table A6: Parents' Contribution from AAI

If parents' AAI is—			The parents' contribution from AAI is—			
Less than -$3,409			-$750			
-$3,409	to	$15,600	22% of AAI			
$15,601	to	$19,600	$3,432	+	25% of AAI over	$15,600
$19,601	to	$23,500	$4,432	+	29% of AAI over	$19,600
$23,501	to	$27,500	$5,563	+	34% of AAI over	$23,500
$27,501	to	$31,500	$6,923	+	40% of AAI over	$27,500
$31,501 or more			$8,523	+	47% of AAI over	$31,500

In the case of our model, the EFC for the family with an I_{total} of $35,000 will be equal to $I_{available}$ * 22%. The EFC for the family with an I_{total} of $35,000 and $125,000 will be equal to $8,523 + ($I_{available \text{ over } \$31,500}$ * 47%).

To calculate the final actual cost of college, the EFC is used to represent the amount an individual is expected to pay as long as the college that individual is attending meets 100% of demonstrated need. If a college does not meet full need, the final actual cost of college is calculated through this formula

$$\text{Final Cost of College} = \text{EFC} + ((1 - \text{Percentage of Need Met}) * (\text{Sticker Price} - \text{EFC}))$$

In this case, the EFC is the minimum amount of funds that an individual must contribute to their college expenses.

2.4 Results and Conclusions

Using the formula to calculate EFC described in section 2.3, the EFCs were found to be the following:

Total Income	$35,000.00	$75,000.00	$125,000.00
1 Parent, 1 Child EFC	$2,009.15	$7,609.53	$27,306.24
2 Parents, 3 Child EFC	$0.00	$4,904.70	$21,027.63

Using the formula, the Final Cost of College can be calculated. This must vary based on the sticker price and the percentage of need the said college meets. For example, if Mike Wazowski's EFC was $30,000, the sticker price of Monsters University was $40,000, and Monsters University meets 80% of demonstrated need, then the Final Cost of College would be $30,000 + ((1 - 0.80)*($40,000 - $30,000)) = $32,000.

2.5 Justifications

While there are many factors that go into the final cost of an undergraduate education that includes scholarship options, it is common belief that, on balance, the EFC that the FAFSA reports will be the final cost. This is true because each university uses the same methodology to determine need-based financial aid eligibility from the school itself. Thus the school will give the student grants and financial aid to bring the cost down to the value that the family can pay, i.e., the EFC. When a student does receive other money in the forms of scholarships, it is believed that the university will reduce their need-based financial aid grant because the scholarship will reduce the need. For example, if the sticker price for one year of Monsters University is $40,000 and the student's Expected Family Contribution is $20,000, then the need-based grant from the school will be $20,000. Let us suppose that the student receives the Mike Wazowski Scholarship, worth $10,000. Then, ideally, the student would only need to pay $10,000. But in reality the university will simply reduce their grant to only $10,000. This means that the student has to pay $30,000. But with the scholarship that price will come back to an EFC of $20,000.

There are a few exceptions to this rule. First, if a student receives a scholarship from the university that brings the final cost below the EFC, then the final cost for the student is that lower value. Second, if you receive an external scholarship that exceeds the difference between the sticker price and your EFC, then you will have some money left over that can be applied to the remaining cost of education and your final price will be reduced. Looking at the previous Monsters University example, if you receive an outside scholarship of $30,000 then when the university withdraws all financial aid, you will still need to pay only $10,000, which is less than the EFC.

2.6 President Obama's Free Community College Program

In response to the high costs of attendance for 4-year universities, President Obama unveiled a new plan during his 2015 State of the Union Address which would make community college free everywhere in the United States. This plan would eliminate the cost of receiving a associate's degree. However, this would not provide any long-term monetary benefit to those who pursue an associate's degree. Further evidence for the benefits of this plan are provided in Section 3.

3. Model 2 (Major - STEM or Non-STEM)

3.1 Analysis of Problem

The rewards of STEM and non-STEM career paths can be estimated by determining the short-term and long-term earning potentials of both fields. This is best determined by calculating the net worth of the average individual on each career path. This is an indicator of the aggregate career returns of each path and can be used as a direct metric of comparison between STEM fields and non-STEM fields. High school seniors deciding on their career paths also have the option of pursuing a two-year associate's degree instead of a four-year bachelor's degree. Furthermore, a high school senior could decide not to pursue any post-secondary degree and directly enter the workforce. The risks and benefits of these two options can also be compared to both types of bachelor's degrees through the metric of net worth.

Thus, the collegiate options of a typical high school senior can be classified into 3 categories: the pursuit of a bachelor's degree in a STEM field, a bachelor's degree in a non-STEM field, or an associate's degree. In addition, a high school senior can choose to directly enter the workforce. Since individuals on different paths would enter the workforce at different times, all paths are evaluated on a timeline beginning at the time of graduation from high school.

3.2 Assumptions

1. The cost of living during college is already incorporated into your college expenses; therefore the cost of living while in a bachelor program is assumed to be zero.
2. For simplicity's sake, the cost of living used will be based on the cost of living of Richmond, Virginia, because Richmond's cost of living is only 3.3% above the national average according to Forbes Magazine.
3. The interest on the college loans begins to accrue as soon as the first loan is taken out (my fed loan).
4. If an individual has excess money (money left after covering cost of living), that excess money will be put towards paying off college loans.
5. The unemployment rate for each career choice and major is assumed to be constant throughout the time period. The justification of this assumption is that the business cycles leading to fluctuations in unemployment rates are too unpredictable to estimate within the scope of this model. Over time the average unemployment rate shouldn't fall too far above or below the assumed value. Additionally, in the case of a really bad recession or a

boom, most careers should be affected relatively similarly, and we are only interested in the differences between career choices.

6. Taxes were not taken into account; incorporating taxes downscaled net earnings, but this showed little to no difference in differentiating between the different ranges.

3.3 Design

This model compares the earning potential of individuals split by career type (STEM vs. non-STEM) and career path, i.e., straight into the workforce out of high school, pursuing an associate's degree, or pursuing a bachelor's degree. The model was developed by tracking the total net worth of individuals through different tracks: STEM majors, non-STEM majors, associate's degrees, and only high school diplomas.

A raw data set was used to determine descriptive statistics for STEM and non-STEM degree holders. This data set was obtained from the data set regarding college majors on FiveThirtyEight's GitHub page, which is accredited by statistician Nate Silver.

The model utilizes the following variables:

- Y - number of years since entering college
- W_Y - net worth accrued up to year Y
- I - expected annual income (unspecified)
    - I_{ECP} - expected annual income earned in the Early Career Phase (first 5 years after college)
    - I_{MCP} - expected annual income earned in the Main Career Phase
- E - employment rate (unspecified)
    - U_{ECP} - employment rate during the Early Career Phase (first 5 years after college)
    - U_{MCP} - employment rate during the Main Career Phase
- M - median salary
- L - annual cost of living
- C - annual cost of college (unspecified)
    - C_4 - annual cost of a four-year college
    - C_2 - annual cost of a two-year community college
- i - annual interest rate on college loans
    - O - previous inherited balance

Constant	Value
Employment rate for people with just high school diploma	81.1%
Median income for people with just high school diploma	$34,528

Employment rate for people with associate degree	95.6%
Median income for people with associate degree in early career phase	$40,645
Average median income for people with associate degree in main career phase	$48,045
Employment rate for people with non-STEM major in early career phase	92.49%
Employment rate for people with non-STEM major in main career phase	94.16%
Median income for people with non-STEM major in early career phase	$32,992
Median income for people with non-STEM major in main career phase	$52,242
Employment rate for people with STEM major in early career phase	93.62%
Employment rate for people with STEM major in main career phase	95.28%
Median income for people with STEM major in early career phase	$41,563
Median income for people with STEM major in main career phase	$66,838
C_2 (assumed constant)	$2,713
i	4.66%
L	$21590.40

Within each track, the model begins with 4 years spent in college for a bachelor's degree and 2 years for an associate's degree. During these college years, the individual's net worth is determined by the following formula:

$$W_Y = -C + W_{Y-1}(i + 1),$$

which indicates that the individual is gradually accruing debt during these years. W_0 is simply equal to zero. For all instances of the model, the expected annual income, I, is estimated for an aggregated population of individuals by the formula

$$I = E * M ,$$

which accounts for the workers within each group that are unemployed within each career track. After college, individuals with bachelor's degrees enter their early career phase (ECP). During this phase, the individual's net worth in a given year Y is given by the following formula:

$$W_Y = I_{ECP} - L + W_{Y-1}(i+1).$$

This formula is only valid while W_{y-1} is negative. The ECP lasts for the first 5 years of the individuals' careers. After the ECP, the individuals enter the Main Career Phase (MCP), which constitutes the remainder of that individual's career. For the MCP, the individual's net worth is given by

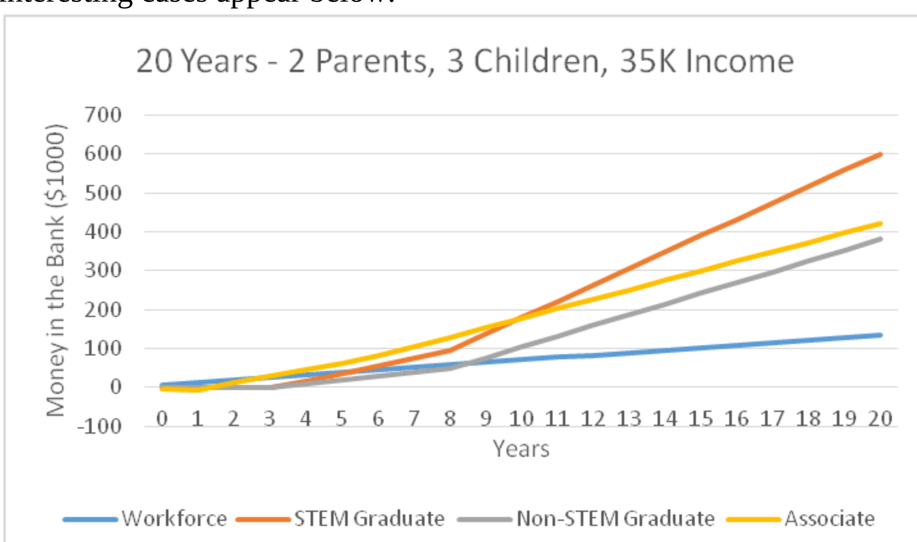
$$W_Y = I_{MCP} - L + W_{Y-1}(i+1).$$

Once again, this formula is only valid while W_{y-1} is negative. Once W_{y-1} becomes positive, we must use the following formula for the worth in year *Y*:

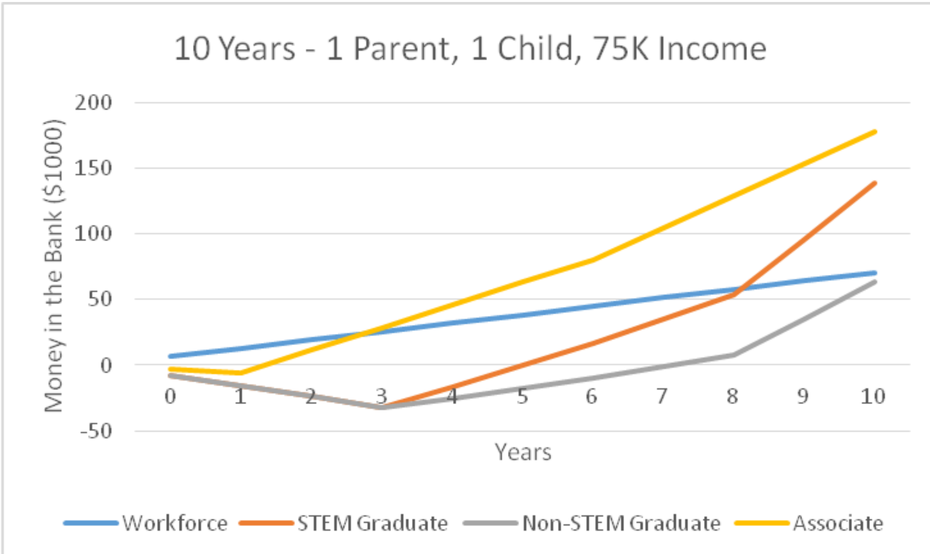
$$W_Y = W_{Y-1} + I_{MCP} - L.$$

3.4 Results & Conclusions

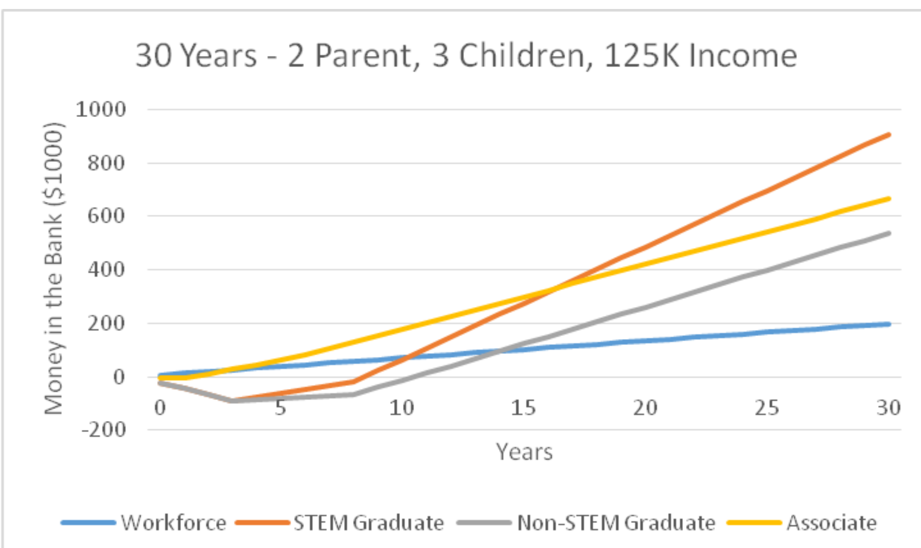
Using the tuition costs found in Model 1 and the formulas developed above, we made a graph depicting the net worth of an average person for each familial situation considered in Model 1. Some interesting cases appear below.



This graph shows the options for a student from a low-income family. It can clearly be inferred from the graph that the best option for such a student would be to obtain a STEM degree. Over the course of twenty years from the time the student enters college, he or she would make about $200,000 more than they would following the second best option, obtaining an associate's degree. It's also very interesting to note that it's more beneficial over the course of these twenty years for the student to obtain an associate's degree than a bachelor's degree in a non-STEM field. Furthermore, it is clear that it is not beneficial whatsoever for the student to go right into the workforce.



This graph is interesting because it shows both the strength of an associate's degree and the weakness of a non-STEM bachelor's degree. If making a significant amount of money in a short time span is of interest to a student, then obtaining an associate's degree is even better than going straight into the work force within 3 years. Meanwhile, if the student had chosen to obtain a non-STEM bachelor's degree, then he'd have a lower net worth than he would from any of the other three options after three years.



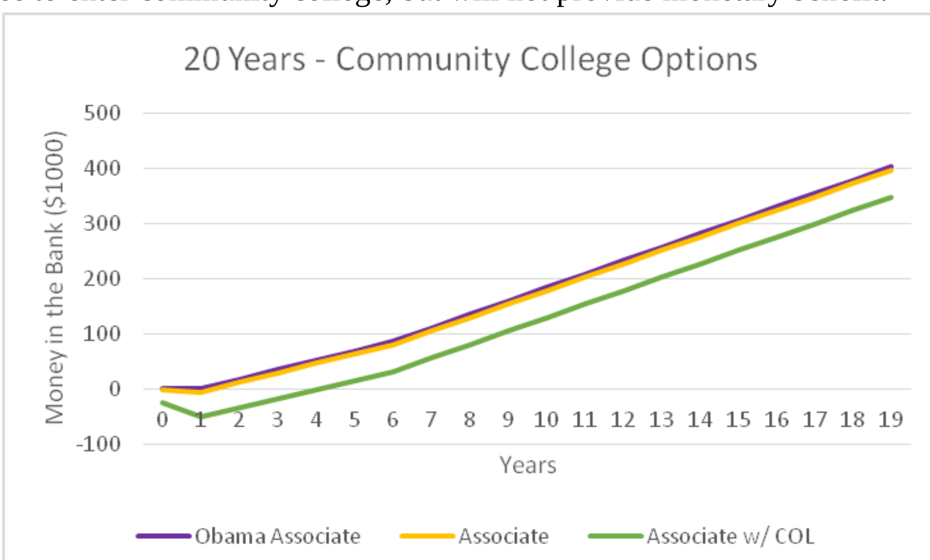
This graph is the best overall representation of what our model is telling us. In the long run, STEM degrees are the most economically beneficial choice. Also, much more surprising is the fact that associate degrees appear to be a better economic choice than bachelor degrees in non-STEM fields.

3.5 Explanation of Results

The reason for the economic superiority of STEM degrees is straightforward. It takes time and skill to become a STEM professional, which, in addition to our rapidly developing modern world, has led to a great demand for such people. However, the reason for the apparent economic superiority of associate degrees over non-STEM bachelor degrees isn't quite as self-evident. A possible reason for this would be that those who are going into an associate program are much more interested in learning a "practical" skill than learning the academic information a four-year student would be interested in. Our model is not the first result to suggest that obtaining an associate degree may be more economically beneficial than certain bachelor's degrees. CNN Money actually wrote an article on this phenomenon, which we have cited in our references. This possible truth should certainly be taken into consideration by people choosing between career paths.

3.6 Evidence for Free Community College Program

The results provided by this model show that, under nearly all financial circumstances, an associate's degree provides a greater monetary return in the first 10 years than any other education plan. This estimate assumes a defined annual cost for community college. President Obama's plan to make community college free would make the community college route even more appealing to high school students desiring short-term returns. As shown in the graph below, the plan would eliminate the cost of attending community college, which is less than $6000. This results in a marginally higher net worth curve, which will not cause any significant advantage in the long run. In the short term, this may motivate more high school students who are considering associate's degree to enter community college, but will not provide monetary benefit.



4. Model 3 (Ranking System)

4.1 Problem Analysis

This problem seeks to tailor a ranked list to each student based on a variety of factors, including individual circumstances, financial desire, and job satisfaction. Some high school seniors may seriously consider a career in STEM fields, while other students may consider a career for the sole reason of supporting their family. This problem seeks to identify a method that can accurately determine which educational choice is right for each high school student.

For our model, we did not look to rank each and every major because that would be unproductive. It is very likely that a Chemistry and a Physics major would not see marked differences in net earnings, happiness, work-life balance, etc. Therefore, we were chiefly concerned in the differences between the types of education: straight into workforce, associate's degree, four-year STEM degree, and four-year non-STEM degree.

4.2 Assumptions

- Survey 1 will be filled out by a simple random sample of employees in each of the 4 education paths.
- Survey 2 will be filled out by high school students.
- High school students are clear on their own job plans.

4.3 Design

For this ranking model we will conduct two surveys to generate data for the model. The first survey will be conducted on a random sample of 10,000 members of the workforce to gather data on which the high school surveys will be ranked.

<u>Survey 1: (Employee)</u>

Q1: What is your level of education?

A) High School Degree
B) Associate Degree (two-year)
C) Four-year STEM degree
D) Four-year non-STEM degree

Q2: How many hours do you spend with your family each working day? ____________

Q3: How satisfied are you with your choice of career on a scale of 1-10, with 1 being extremely dissatisfied and 10 being extremely satisfied? ____________

Q4: How stressful is your career on a scale of 1-10, with 1 being extremely stressful and 10 being not stressful at all? ___________

<u>Survey 2: (High School Student)</u>

R1: Which of these does your parents' income come closest to?

A) $35,000 B) $75,000 C) $125,000

R2: Pick the statement that best corresponds to you:

A. I require a stable income in the short run.
B. I am willing to invest more time in a degree to earn a higher long-term income.

R3: Do you want to pursue a career in Science, Technology, Engineering, or Math? YES or NO
R4: How important is work-life balance to you on a scale of 1-10, with 1 being extremely unimportant and 10 being extremely important? __________
R5: How satisfied do you want to be with your job on a scale of 1-10, with 1 being extremely dissatisfied and 10 being extremely satisfied? __________
R6: How open are you to having a stressful job on a scale of 1-10, with 1 being extremely unimportant and 10 being extremely important? __________

Now, we will analyze the purpose of each question. For Survey 1, Q1 determines the type of education for the given employee. Based on this, the rest of the answers will be tagged with his education. Q2 looks for work-life balance. Q3 looks for job satisfaction. Q4 looks for job stress levels. This survey only tests for the qualitative values. This does not garner information on income because income would have already been determined by Model 2.

After this survey we should have a series of data points to use for the ranking. In Survey 2, R1 is used to determine which Net Earnings value we will use from Model 2 based on family economic situation. R2 determines whether the student needs money immediately, which will force the model to use the 10-year value because it represents short-term earnings. R3 is used to determine, without the use of the model, if the person is automatically best suited for a four-year STEM degree. If the student selects yes for this question (R3), then a weight will be added to his final four-year STEM degree rating. R4 is used to determine the importance placed on work-life balance. R5 is used to determine the importance placed on job satisfaction. R6 is used to determine the student's willingness to handle stress in their jobs.

Unweighted Rating
$U_R = R_W + R_H + R_J + R_S$
Personal Rating
$P_R = R_W + R_H W_H + R_J W_J + R_S W_S$

R_W = Net Worth Ratio

- W_A = Average net worth for specific combination of Degree and Time Frame and Parental Income
- W_M = maximum possible Net Worth out of all possible combinations of Degree and Time Frame and Parental Income

$$R_W = \frac{W_A}{W_M}$$

R_H = Work-Life Balance Ratio

- H_A = Average number of hours spent with family (indicative of work-life balance)
- H_M = Maximum hours spent at home out of all Degree types

$$R_H = \frac{H_A}{H_M}$$

R_J = Job Satisfaction Ratio

- J_A = Average satisfaction
- J_M = Maximum satisfaction achieved out of all Degree types

$$R_J = \frac{J_A}{J_M}$$

R_S = Stress Ratio

- S_A = Average Stress
- S_M = Maximum Stress

$$R_S = \frac{S_A}{S_M}$$

Weights - For each component Work-Life Balance (W_H), Job Satisfaction (W_J), and Stress (W_S), W_X can be determined by

$$W_X = \frac{V_X}{\mathbf{10}},$$

where V_X is a value between 1 and 10 as listed in the survey response for that component.

4.4 Model Application & Justification

First, Survey 1 will be randomly distributed and data will return. At this point, each type of degree will have various data points. For each qualitative variable (work-life balance, job satisfaction, and stress), an average of all the data will be taken for each degree type. Therefore, at the end of this procedure, the associate's degree will have an average value for each qualitative variable, as will the other 3 types of degrees. For the Net Worth variable, the Max value is the maximum earning potential out of all the combinations of degrees and time frames of earning. Based on the student survey questions R1 and R2, we will determine which graph from Model 2 to use in order to select a Net Worth (Money in the Bank) for that combination of degree, parental income, and time frame of earnings (10 or 30 years). Then each average value, including Net Worth, will be divided by the maximum possible value in that category. Therefore, we will get a series of ratios for each type of degree. For each degree type, the ratios will be added to create a base rating value for each type of degree. This creates the unweighted ranking for high school students which will be the same for everybody with the same responses for R1 and R2.

For the personalized survey, individual weights will be ascribed to each ratio based on the importance each student places on each variable. For example, if Ferris Bueller took this test and gave stress a score of 7 in terms of his job, his weight for that category would be 7/10. Therefore, for each type of degree, that average stress value would be multiplied by 0.7, diminishing the effect of that variable. On the other hand, if he gives job satisfaction a 10, then his weight for that would 10/10. So, for each type of degree, the average job satisfaction value would be multiplied by 1.0, giving that category a large weight for the final rating. Through this method, the student's importance on certain categories can be taken into account, and the final ratings will be listed in order from largest to smallest. The largest rating will be the best educational option for the student, while the smallest rating will be the worst education option for the student.

5. Strengths and Weaknesses

Our model provides an excellent way of determining the overall actual cost of college attendance, incorporating both short- and long-term liabilities and rewards of entering the work force with or without a STEM-related degree, and providing a ranking system for high school students to make informed education choices.

Model 1 is based on the existing calculation for financial aid that is used by institutions of higher learning throughout the United States. Model 1 does not account for unusual family circumstances, which can drastically and unpredictably affect financial aid packages. In addition, it does not account for financially independent students. However, it can be used universally for all colleges, despite different college costs.

One of the greatest strengths of Model 2 is its flexibility for tuition. The model can be altered to model career incomes for various college cost totals. In addition, this model incorporates data from a large data set of occupational earnings information, which incorporated large sample sizes in the model, providing greater accuracy. However, the model's calculations do not account for personal investment by an individual upon entering the workforce. This could potentially allow an associate's degree holder to keep pace financially with a STEM bachelor's degree holder if the former made smart investments.

In Model 3, Survey 1 provides an accurate snapshot of the workforce as it stands. Because of this, Model 3 ranks educational plans based on actual data collected from a survey, instead of estimated job market information. In addition, Survey 2 takes into account the preferences of high school students for career plans.

6. Conclusion

In our solutions, we created three mathematical models to address estimated actual college costs, project both short-term and long-term advantages and disadvantages of entering the workforce with a STEM-related degree, and rank the educational and career options available to high school students.

In our first model, we utilized the preexisting national federal financial calculator utilized by higher level educational institutions in the U.S. Our model determined the Expected Family Contribution for specific family financial scenarios. It also uses the EFC values to calculate a final actual cost based on the financial need fulfilled by colleges.

Our second model projected the career earnings for STEM and non-STEM majors. This model utilized data on a wide number of occupations to track the net worth of individuals from educational backgrounds. The results of this model showed that an associate's degree from a community college provides the fastest financial return in the short run, yielding the greatest net worth within 10 years after graduating high school. However, in the long run, STEM majors had the highest net worth in all financial circumstances, and exceeded the net worth of non-STEM bachelor's degree individuals at any time. In addition, all forms of education resulted in higher net worth in the long run than those who directly entered the workforce.

Finally, we developed a third model that evaluates the advantages of each educational path. These models use a pair of surveys: the first gives us significant data about the condition of the current workforce from each of the four educational backgrounds, and the second collects information from high school students to determine their professional preferences. This information is used to determine a Personal Rating for each of the backgrounds, which can be used to rank them based on a student's career plans.

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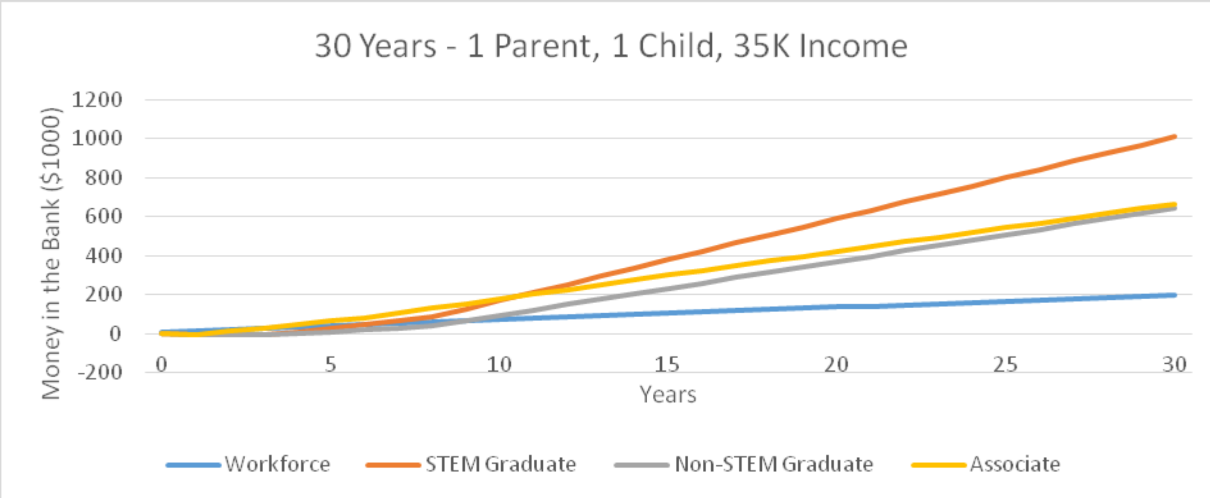
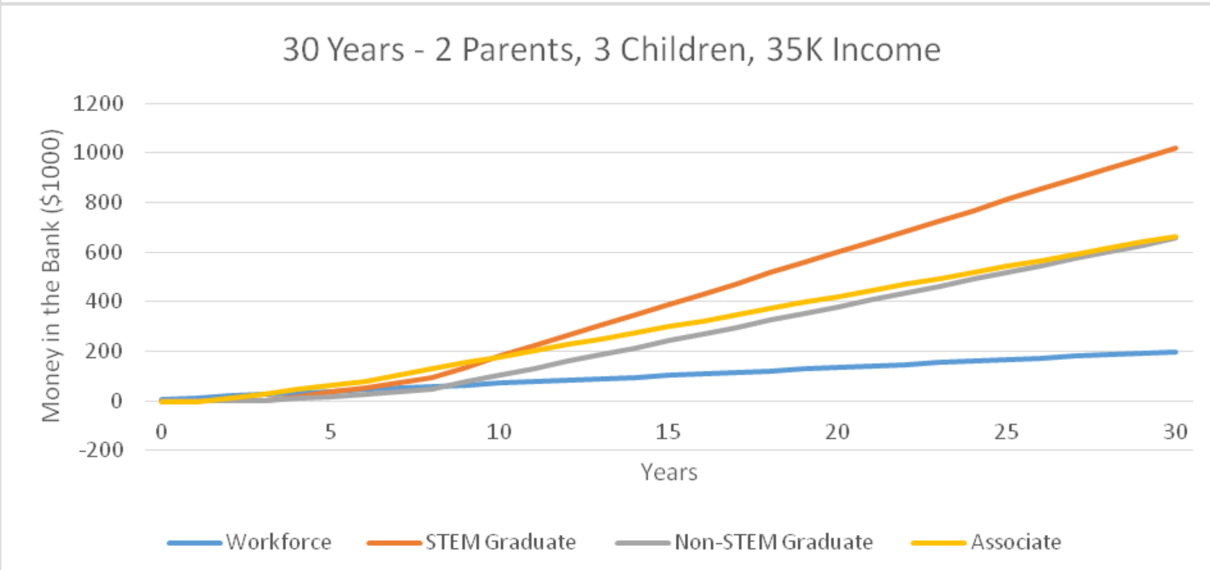
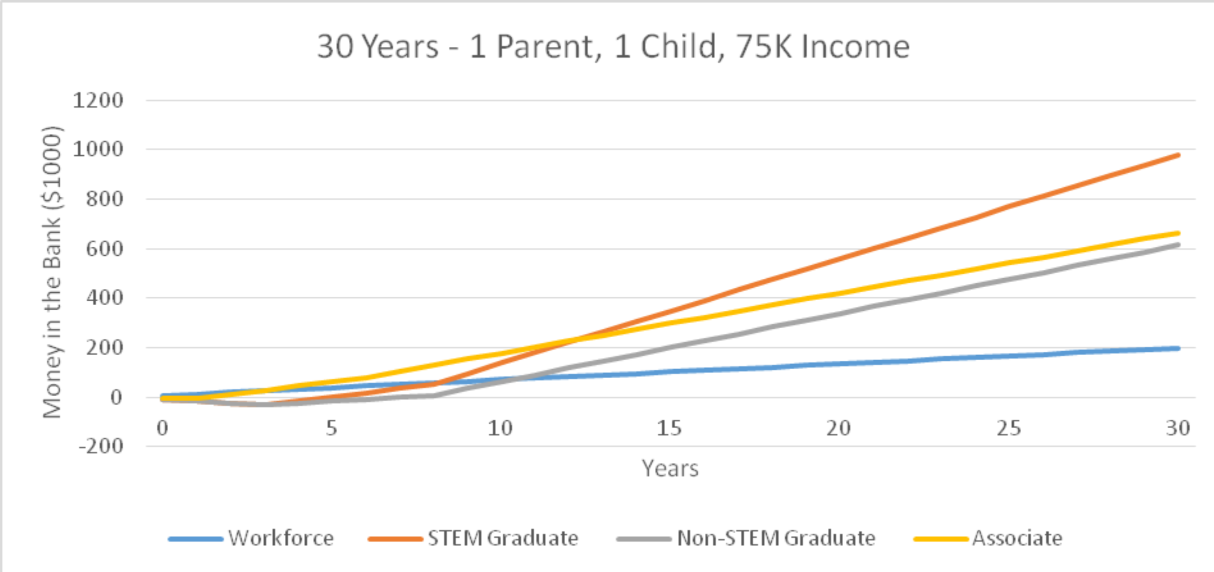
Appendix


30 Years - 1 Parent, 1 Child, 35K Income
Money in the Bank ($1000)
1200
1000
800
600
400
200
0
-200
0
5
10
15
20
25
30
Years
Workforce
STEM Graduate
Non-STEM Graduate
Associate


30 Years - 2 Parents, 3 Children, 35K Income
Money in the Bank ($1000)
1200
1000
800
600
400
200
0
-200
0
5
10
15
20
25
30
Years
Workforce
STEM Graduate
Non-STEM Graduate
Associate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Money in the Bank ($1000)
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1000
800
600
400
200
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-200
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5
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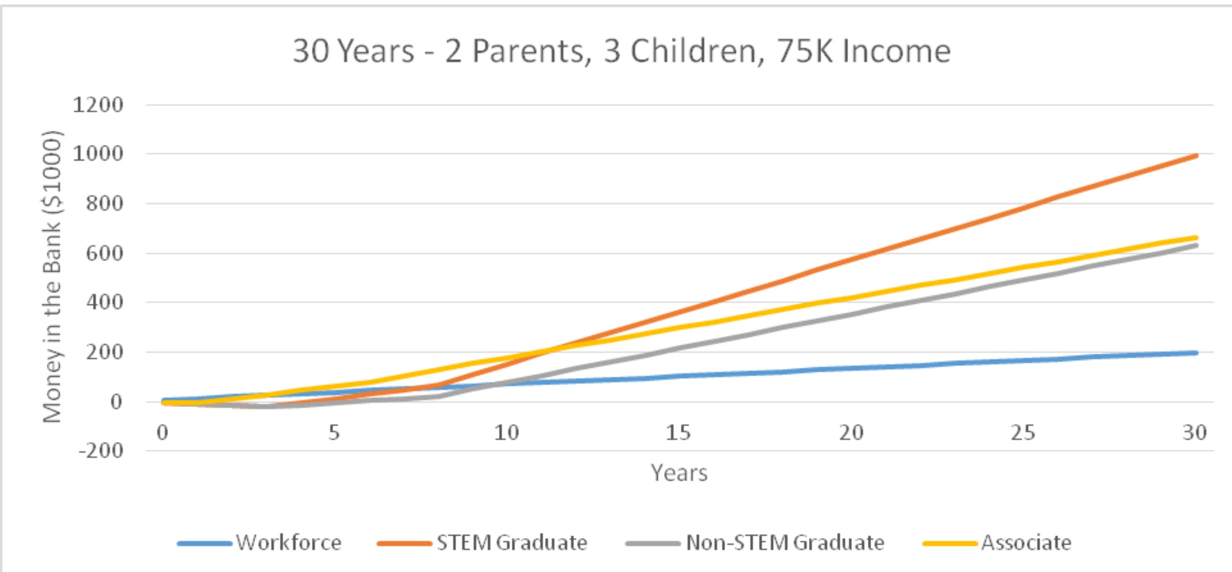
15
20
25
30
Years
Workforce
STEM Graduate
Non-STEM Graduate
Associate


30 Years - 2 Parents, 3 Children, 75K Income
Money in the Bank ($1000)
1200
1000
800
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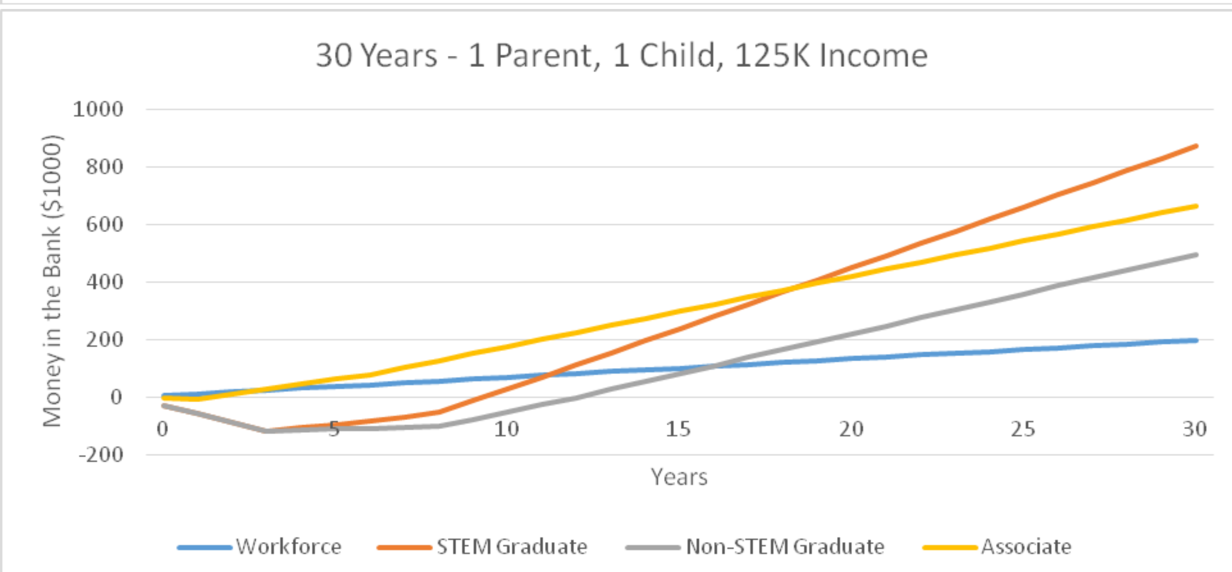
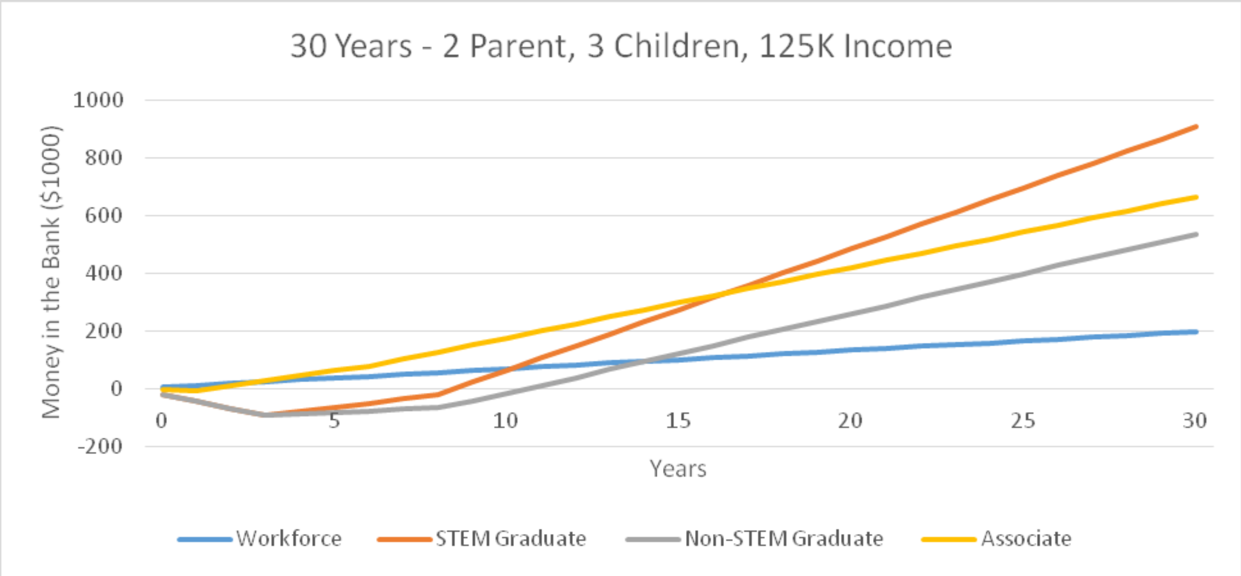
Years
Workforce
STEM Graduate
Non-STEM Graduate
Associate


30 Years - 1 Parent, 1 Child, 125K Income
Money in the Bank ($1000)
1000
800
600
400
200
0
-200
0
5
10
15
20
25
30
Years
Workforce
STEM Graduate
Non-STEM Graduate
Associate


30 Years - 2 Parent, 3 Children, 125K Income
Money in the Bank ($1000)
1000
800
600
400
200
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-200
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25
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Years
Workforce
STEM Graduate
Non-STEM Graduate
Associate