Staples High School– Team #5057, Westport, Connecticut
Coach: Kerrigan Warnock
Students: Chaihyun Kim, Claudia Landowne, Claire Sampson, Madeline Schemel, Terrie Yang

M3 Challenge Fourth Place Team, Meritorious Team Prize: $7,500

***Note: This cover sheet has been added by SIAM to identify the winning team after judging was completed. Any identifying information other than team # on an M3 Challenge submission is a rules violation.

*****Note: This paper underwent a light edit by SIAM staff prior to posting.**

STEM Sells: What is higher education really worth?

Dear high school administrators:

This year, we were asked to mathematically examine the problems surrounding higher education, namely its cost. We approached this idea by evaluating the cost of various degree choices, including a high school degree, a two-year community college degree, as well as STEM and non-STEM degrees received from public and private colleges.

The first part of our model involves an estimation of the cost of college for individuals of 1 parent, 1 child families and 2 parent, 3 children families of various annual incomes (including $35,000, $75,000, and $125,000). In order to estimate the total cost of college for each of these families, we took into account many factors, including pre-set institution costs, variables such as transportation and recreational costs, the total amount of student aid and scholarships, and finance charges for student loans.

The second part of our model involves estimating the future benefits of each of the possible college plans. This model took into account the earning potential, financial stability, and student debt received from each type of degree (high school, 2-year community college, private STEM, public STEM, private non-STEM, and public non-STEM). Earning potential was designed to calculate future earnings and growth in earnings over the course of the individual's career, provided by each level of education. Financial stability takes into account the likelihood that an individual will be able to continue working. This involves the likelihood that the individual will be injured on the job as well as the future outlook for jobs in that field. Student debt takes into account the average student debt incurred because of the cost of higher education. From this, we were able to determine a base value, based solely on monetary gains, for each form of degree and education level. This base value, which was rated on a scale from 0 to 4, was then used as a basis for the third part of the model.

The third part of our model combines qualitative factors with previously determined quantitative ones in order to create a ranking system high school students could use to see which educational option would offer them the best overall quality of life. This final segment of the model incorporated a student's predisposition towards happiness, classroom and workplace skills, and desired standards of living with the previously calculated rankings of various kinds of educational institutions. Using this model, students are able to weigh their educational options in a straightforward, ranked format while still being able to see a breakdown of their results and why their options are ordered the way they are. Of course, because a fair number of the variables considered in this model are qualitative, they are highly changeable and not as reliable as hard numbers. However, we did try to measure qualitative factors in as quantitative way as possible, so our margin for error is minimized.

Thus, our model provides an accurate and comprehensive analysis of the value of college that can be customized for any student. I would strongly encourage you to employ our ranking system, the product of our several models, in order to aid your students.

Thank you for your consideration,
Team #5057

Outline

Problem Statement:
College education is expensive and a concerning issue for many American families. We aim to ease these anxieties by:
1. Computing a cost analysis that will model a student's total net cost.
2. Determining the short and long term liabilities of various secondary education paths.
3. Using the above to create a model high school students may use to aid their college and life decisions.

Part I: How Much Does an Individual Student Pay for College?

It is no secret that the cost of college education is on the rise, along with the cost of living in America. With this reality in mind, it is important for high school students to be cognizant of the opportunities for financial aid available to them, along with the flexibility that many of these monetary aid programs provide. No longer is financial aid comprised solely of costly loans; instead, it is possible for financially needy students to receive large grants that pay for the cost of living in addition to college tuition. Thus, our model aims to educate students not only of the subtleties of the cost of an undergraduate education but also of the available financial aid. The format of our model is a survey to be taken by the student, and our model is used to calculate the final totals of aid provided, which will be output to the user.

Model:

$$\textbf{Total Cost}_{\textbf{(in U.S. dollars)}} = \sum_{i=1}^{n} [\alpha(n) + \beta(n)] - \delta n + \sum \gamma$$

where n = number of years spent in college, α = institutional expenditures, β = cost of living, δ = financial aid and scholarships, and γ = finance charges

$\alpha(n)$	$\beta(n)$	δ	$\gamma(P, i, m)$

A function of the number of years spent at "x"-college, determined by the pre-set institution costs, available on each college website	A function of the number of years spent at "x"-college, determined primarily by the location of "x"-college (rural vs. urban)	A function of the number of years spent at "x"-college, determined by the amount of federal, state, institutional, and private aid	A function of student loan principal, daily periodic interest rate, and number of months.
$\alpha(n)$ = n [Tuition + required school fees + room & board (if applicable) + books & supplies]	$\beta(n) = n(D + R + F)$ D(x) ={2y(50 + .11x, if flying {2y(.592 x), if driving {2y r n , if train or bus R(n) = {1.18(2470), if urban {2470, if rural F(n) = meal plan cost	$\delta(n)$= n [Federal pell grants + state grants + institutional grants + private scholarships + yearly income]	$\gamma(P, i, m) =$ $mP(i + \frac{i}{(1+i)^m - 1}) - P$

Explanation and Assumptions of the Above Equations:

$\alpha(n)$**:** Comprised primarily of constants and should be determined by the student's own research of their college of interest. All values should be easily available when searched for on the college website. Because of the variability dependent on institution, we are assuming the student has access to this data and can input it in the Total Cost Schedule.

$\beta(n)$**:** Because "cost of living" is a nuanced value, our model aims to simplify it by creating an estimation based on values deemed vital to a student's "college experience." This simplification assumes the student is a frugal spender.

D(x) is a value of the average cost of transportation, assuming the student is either flying, driving, or taking transportation with a flat rate to their college. On average for flying there is a constant fare of $50 added to an average of $0.11 per mile. For driving the average mile is $0.592. In all other forms of transportation there is typically a flat rate, "r". Additionally, "y" is multiplied by all values to account for the number of times the student expects to go home; the 2y in the equation accounts for this being a round trip. Since most colleges close during longer breaks and over the summer, it is expected the student will go home on average 10 times (for summer, Thanksgiving, Winter, and Spring break).

R(n) is a value of recreational expenditures, taking into account cell phone cost, movies, shopping, concerts, and other activities the student may be involved in during their time in college. According to the U.S. Department of Labor, the cost of living is approximately 18% more in urban areas than in rural areas, which explains the coefficient of n, the number of years spent in college. The value 2470 is an average number of dollars the student is expected to spend during their college year. This value of course is quite variable based on the student and their own personal interests and habits, but in order to simplify we left it as a constant value to be multiplied by the number of years spent in college.

F(n) is a value of the meal plan the student chooses to use at their college, a value that should be accessible via the school's website. This assumes the student remains on a meal plan during their college years.

$\delta(n)$: This section of the formula takes into account the values that are subtracted from the student liability cost. This includes federal aid, state aid, private scholarships, institutional aid, loans, and a student's yearly income. Because financial aid is entirely dependent on the student's FAFSA and the institution they will attend, these values should be researched by the student prior to filling out the survey. Numerous calculators are already available online that will outline the cost for the student to provide. The income the student provides in the survey is projected and includes the entirety of the student's income throughout the school year and summer.

γ **:** Given the cost of the above variables, a student may choose to take out a federal, institutional, or private loan. This variable represents the interest accrued on student loans using the monthly payment formula, which is then added to the prior cost to produce the total net cost.

Total Cost Schedule (to be taken by the high school student):

Note to student: When filling out this form, please have a specific secondary institution in mind, and either research the needed values or estimate them. Input values for a single year. The program will take into account the total expenditures over your time spent at this college. Additionally, the program will take into account the average cost of living for a student in college, so simply input the values asked for.

Number of years expected to be spent at this institution		
If an urban school, check yes		
If a rural school, check yes		
Tuition	Pre-set institutional costs, available on each college website	
Required school fees		
Room		
Books		
Meal Plan/food		
Travel Cost		
Distance from home to school (in miles)		
If flying, check yes		
If driving entire way, check yes		

If travelling by other means, input cost of travel one way		
Scholarships and Estimated Financial Aid		
Federal aid (determined by FAFSA):	Go to https://fafsa.ed.gov/FAFSA/app/f4cForm?execution=e1s1 to determine your federal aid	
Grants		
Loans		
Work-study		
State/local grants	Estimate, if applicable	
Institutional grants	Go to the Net Price calculator on your institution's website to calculate	
Private scholarships		
Projected yearly income during college		

Application of Model:

In order to determine the location of the sample students, we used random.org to generate a value that corresponded to a position in the alphabetical list of all 50 states; Connecticut was the chosen state. Additionally we chose to locate the students in Fairfield County to determine travel expenses since we felt the region had an adequate financial distribution of wealth for all scenarios.We assumed for families with incomes of $35,000 that the students would attend community college since according to a national survey of first-time college students in 2003-04, among students of family incomes of $32,000 or lower, 57% started their undergraduate career at a 2-year college (Community College Research Center). We assumed this student will not attend a 4-year institution afterwards to complete their secondary education, but if needed the student could use the calculator again for the new college. Likewise, we assumed the $75,000 income families would choose public universities and the $125,000 income families would choose private universities. We chose Norwalk Community College, University of Connecticut, and Yale University to provide an adequate balance of urban and rural institutions. We assumed that family income remains constant for all four years to keep the estimated financial aid value a constant as well. We used a value of $0 in assets, assuming that no family had assets significant enough to greatly affect financial aid. For siblings, we used the statistic that the average age gap between siblings is 2.5 years in the United States ("The Art and Science of Child Spacing").

Sample Student Schedule for Scenario #1:

Number of years expected to be spent at this institution		4
If an urban school, check yes		✓
If a rural school, check yes		

Tuition	Pre-set institutional costs, available on each college website	3360
Required school fees		426
Room		0
Books		1400
Meal Plan/food		3000
Travel Cost		
Distance from home to school (in miles)		10
If flying, check yes		
If driving entire way, check yes		✓
If travelling by other means, input cost of travel one way		
Scholarships and Estimated Financial Aid		
Federal aid (determined by FAFSA):		
Grants		3480
Loans		5500
Work-study		1465
State/local grants		0
Institutional grants		0
Private scholarships		0
Projected yearly income during college		4408

Example Scenarios:

Scenario #1: Single parent/one child household; annual income of \$35,000, attending NCC $\alpha(n) = 2\,[3360 + 426 + 0 + 1400]$ $\beta(n) = 2\,[1.18(2470) + 2(160)(.592)(10) + 3000]$ $\delta(n) = 2\,[3480 + 4408]$ $\gamma(P, i, m) = 85.18$ Total Net Cost: \$10,299.18	**Scenario #2**: Two parent/three children household; annual income of \$35,000, attending NC $\alpha(n) = 2\,[3360 + 426 + 0 + 1400]$ $\beta(n) = 2\,[1.18(2470) + 2(160)(.592)(10) + 3000]$ $\delta(n) = 2\,[4780 + 4408]$ $\gamma(P, i, m) = 85.18$ Total Net Cost: \$7,699.18

Scenario #3: Single parent/one child household; annual income of $75,000, attending UConn $\alpha(n) = 4\,[9{,}858 + 2{,}902 + 6{,}466 + 925]$ $\beta(n) = 4\,[2470 + 2(10)(.592)(100) + 5{,}608]$ $\delta(n) = 4\,[4760 + 4408]$ $\gamma(P, i, m) = 85.18$ Total Cost: $81,065.18	**Scenario #4:** Two parent/three children household; annual income of $75,000, attending UConn $\alpha(n) = 4\,[9{,}858 + 2{,}902 + 6{,}466 + 925]$ $\beta(n) = 4\,[2470 + 2(10)(.592)(100) + 5{,}608]$ $\delta(n) = 4\,[9770 + 4408]$ $\gamma(P, i, m) = 85.18$ Total Cost: $61,025.18
Scenario #5: Single parent/one child household; annual income of $125,000, attending Yale $\alpha(n) = 4\,[44{,}800 + 1{,}065 + 12{,}456 + 4{,}244]$ $\beta(n) = 4\,[(1.18)2470 + 2(30)(.592)(10) + 6{,}200]$ $\delta(n) = 4\,[58825 + 4408]$ $\gamma(P, i, m) = 85.18$ Total Cost: $35,292.38	**Scenario #6:** Two parent/three children household; annual income of $125,000, attending Yale $\alpha(n) = 4\,[44{,}800 + 1{,}065 + 12{,}456 + 4{,}244]$ $\beta(n) = 4\,[(1.18)2470 + 2(30)(.592)(10) + 6{,}200]$ $\delta(n) = 4\,[58825 + 4408]$ $\gamma(P, i, m) = 85.18$ Total Cost: $35,292.38

Note: Although not predicted, the cost of attending a private institution (Yale) for Scenarios 5 and 6 was in actuality less expensive than the cost of an in-state public school. This is likely because of the institutional aid that a private school such as Yale, an Ivy League elite institution, is able to provide to its students due to their large endowment. Yale has an endowment of $23.9 billion, which provides ample money for financial aid, as opposed to University of Connecticut's endowment of $396.5 million; Yale has a 6027% greater endowment. This also demonstrates the discrepancies between different institutions.

Effect of College Promise Proposal:

With Obama's latest declaration that community college would now be free for students who qualify, we analyzed how this would affect our model. Hypothetically, the proposal would have little to no effect on our model. Community college already has a low cost, and the Obama administration has increased the maximum in Pell Grants provided to students to $5,775 for the 2015-16 school year. The average community college cost for a public 2 year college was $2,713 for the 2010-11 school year (Trends in Higher Education Series 2011). Thus students who qualify for the maximum federal aid grants available will have no added cost of attending community college (Federal Student Aid). Therefore the only students this proposal helps are those who do not qualify for the maximum amount of grant aid, but who still wish to attend a community college. These students are likely from families with incomes greater than $50,000, but if their family income is too much greater than this, this might mean that these students are more likely to attend a 4-year institution instead of a 2-year one.

Part II: Liabilities of Various Educational Opportunities

The monetary value of different educational opportunities varies based on a short-term and long-term basis. While the initial cost of college is an important deciding factor in determining one's college choices, it is also necessary to consider opportunities received from various levels of education. In this section, we will attempt to mathematically quantify the expected opportunity from high school degrees, 2-year community college degrees, and college degrees in STEM and non-STEM fields using criteria based on earning potential, financial stability, and expected student debt.

Financial Stability

Assumptions:

1. The probability of injury P(I) remains constant for all years.
2. Assume E (starting salary) and P (maximum salary) are increasing at the same rate as the median salary.

Our measurement of financial stability is based on the probability of workplace injuries and the future outlook of the job market (for example, if available careers in that field are growing or shrinking).

First, we calculate the probability of an individual suffering a work-related injury using the equation:

$$P(I) = \frac{I}{T}$$

where

I = the number of workplace injuries, and
T = the total number of workers with the given occupation.

Then the probability of not suffering a work-related injury is

$$P(I_0) = 1 - P(1)$$

The second measure of financial stability involves whether or not the field in which an individual wants a career is growing or shrinking. We measured this by plotting a graph of the median salary in each occupation over the past decade or so and then extrapolating that data to find the change in salary and project future salaries. This allows us to calculate the future entry-level and peak salaries an individual can expect to earn. The equations for this are:

$$P(t) = P_0 + mt$$

$$E(t) = E_0 + mt$$

Earning Potential

Assumptions:

1. The individual begins working at age 22 and retires at age 65. We believe that this is a reasonable assumption given that most people will enter the workforce upon graduating college at the age of 22 and that the retirement age is 65. The age of entering the

workforce and time of retirement varies among high school graduates and community college graduates, but the effect is negligible in terms of the final output of our model.

2. All individuals start with the entry level salary and end with a peak salary.

In order to estimate earning potential we created a mathematical model to estimate the annual salary of the individual in any given year. Our model for earning potential is designed to show the changing salaries of each individual as they advance in their career. This allows the model to show the varying short-term and long-term benefits and liabilities of each career path. The equation used is

$$Earnings = \frac{P(t)}{1 + \left[\frac{P(t)}{E(t)} - 1\right]e^{-kt}}$$

where

P(t) = peak salary for profession (calculated in the financial stability section),
E(t) = entry level salary for profession (calculated in financial stability section),
t = time in years, and
k = a scaling factor used to change the slope of the logistic function = 0.1.

Student Debt

Assumptions:

1. The interest on the loan is compounded annually.
2. Individuals are required to pay a minimum dollar amount of their loan each year, and that is the amount they pay each year.
3. It takes 10 years for each student to pay off their loan.

Student loans are an important factor in determining the future benefits and liabilities of various college choices. Our model for determining the future effect of student loans is designed to calculate the amount an individual will pay on student loans each year.

First, the total student debt is then calculated using the equation

$$SD = C(1+r)^t$$

where

SD = the remaining student debt,
t = time in years (since entering the workforce), and
r = interest rate (written as a decimal).

Then the amount paid each year is calculated using the equation

$$S = \frac{SD}{10}$$

where

SD = total student loan (including interest), and
S = amount paid each year.

Final Calculations

In order to compare the long-term and short-term effects of each possible college decision, we used the above categories to determine an estimate for the net annual salary earned as a result of each level of education. This was done using the equation

$$f = Earnings \bullet P(I_0) - S$$

where

f = net annual salary,
Earnings = annual income (calculated above),
$P(I_0)$ = probability of being healthy (calculated above), and
S = amount paid on student loans.

This equation can be used to determine the expected monetary benefits from each college choice based on the number of years since entering the workforce. As a result, we can calculate the short-term and long-term benefits of each level of education. This allowed us to calculate a base ranking level for each of the possible decisions regarding higher education.

First, we calculated a baseline using the individual's average earnings, injuries in the workplace, and payments on student loans. The equation for this is

$$B = Earnings_{Median}\left[P(I_{0_{Average}})\right] - S_{Median}$$

where

$Earnings_{Average}$ = the median salary of American workers,
$P(I_{0\ Average})$ = the average probability of probability of an individual remaining free of workplace injuries in a given year, and
S_{median} = median amount paid on student loans in the U.S.

This baseline estimate is then used as a comparison for the short-term and long-term benefits of each education level. We used it to create a scale (which outputs values from 0 to 4) on which to rate each education choice. The equations used for this are

$$ST = \frac{2(f_s - B)}{f_s - B + 10{,}000} \qquad LT = \frac{2(f_l - B)}{f_l - B + 10{,}000}$$

where

ST = short term estimation (on a scale of 0 to 2),
LT = long-term estimation (on a scale of 0 to 2),
f_s = monetary benefit estimate for short term (use the equation for *f* with a time of 5 years),

f_l = monetary benefit estimate for long term (use the equation for *f* with a time of 20 years), and

B = baseline (equation above).

These factors are combined and are used to create the ranking scale using the equation

$$Q = LT + ST$$

<u>**Calculations**</u>

We used 5 years for the short-term period and 20 years for the long-term period.

Base Calculations:

Probability of Health = 1 - .035 = .965
Median Salary = 51,017
Median Student Loans = 28400

B = 20831.405

High School Degree Only
Entry Level Salary: 21,000
Peak Salary: 40,500
Probability of Health = .9596
Student Debt = 0
Short-Term Earning Potential = 25617.88
Long-Term Earning Potential = 24467.52
ST = .546
LT = .419
Ranking = Q = 1.929

Community College
Entry Level Salary= 38,407
Peak Salary = 54,604
Probability of Health = .952
Student Debt = 3,700
Short-Term Earning Potential = 42861
Long-Term Earning Potential = 40998
ST = 1.333
LT = 1.291
Ranking = Q = 2.623

Public School Non-STEM Degree
Entry Level Salary = 38,783
Peak Salary = 65,766
Probability of Health = .964
Student Debt = 25,550
Short-Term Earning Potential = 51,283
Long-Term Earning Potential = 66,192
ST = 1.422
LT = 1.623
Ranking = Q = 3.044

Private School Non-STEM Degree
Entry Level Salary = 38,783
Peak Salary = 65,766
Probability of Health = .964
Student Debt = 32,300
Short-Term Earning Potential = 51,283
Long-Term Earning Potential = 66,192
ST = 1.403
LT = 1.729
Ranking = Q = 3.132

Public School STEM Degree
Entry Level Salary = 63,900
Peak Salary = 113,900
Probability of Health = .95
Student Debt = 25,550
Short-Term Earning Potential = 79,584
Long-Term Earning Potential = 86,581
ST = 1.671

Private School STEM Degree
Entry Level Salary = 63,900
Peak Salary = 113,900
Probability of Health = .95
Student Debt = 32,300
Short-Term Earning Potential = 79,584
Long-Term Earning Potential = 86,581
ST = 1.665

LT = 1.719
Ranking = Q = 3.391

LT = 1.719
Ranking = Q = 3.385

Sensitivity Analysis:

Out of the model's 4-point scale, both the long-term and short-term benefits of each education level carry the same weight (two out of the four points). Inside of the short-term and long-term categories, the earning potential, financial stability, and student debt calculations have different effects on the model.

Differences in earning potential carry the greatest weight, as shown by the larger difference between STEM and non-STEM careers than between private and public schools. Student debt carries less weight because the amount of money paid towards student debt is only a fraction of the total earnings. Financial stability also has a smaller influence because the probability of health is similar between most of the occupations.

Despite these differences in weight, we believe that our model provides accurate base rankings for each degree choice as the earning potential outweighs factors such as financial stability and student debt in monetary value.

Part III: Ranking Opportunities Based on Quality of Life

Approach

Measuring happiness is an extremely subjective undertaking, oft attempted, but rarely well. In creating a ranking system by which high school students could weigh their post-high school educational options, we reviewed various other happiness metrics, from Maslow's Hierarchy of Needs to the Kingdom of Bhutan's Gross National Happiness Index. From various methodologies, we parsed a three-step analysis that students can use to combine the quantitative and qualitative values of their future educational options with their own personal predispositions. The analysis is intended to be administered, in the form of a test, early in a student's final year of high school.

Our ranking system uses a weighted points system to order a particular student's best post-high school education options. There are three separate sections in which a student accumulates points. The first section is based on societal averages, and thus its awarded outputs are consistent among all students.

The latter sections were formed using a Valdosta State University adaptation of Maslow's Hierarchy of Needs, updated to suit the development of pre-college youths in the 21st century. Using this adaptation, we determined that our ranking system should address three areas of fulfillment: sociability, goals, and ability. Sociability makes up the entirety of the second section, while goals and ability are both encompassed by the third.

It is also of note that, although our latter sections cannot be done in an entirely quantitative manner, we still attempted to eschew entirely qualitative methodology. If people are directly asked their level of happiness, they are known to proffer inaccurate responses, whether intentionally or not. Thus we preserved quantitative reasoning as best as we could in these sections in order to attain the most accurate rankings for students.

The sections are as follows.

1. Quantitative Societal Base Values

Financial stability, earning potential, and other quantifiable financial factors directly correlate with one's ability to maintain good health, afford cultural and educational experiences throughout life, and set aside the time needed to be an active participant in one's local, regional, and national communities. All of these factors are widely agreed to be positive influences on happiness level; thus happiness can indeed, to some extent, be bought.

Accordingly, we used our model from part 2 of the challenge to determine the base rankings of the level of happiness a high school education, 2-year degree, a STEM degree, and a non-STEM degree garner, based on the financial viability of each of the preceding categories. Additionally, we assigned base values to public and private institutions, so STEM and non-STEM degrees are further divided into those attained at private versus public institutions. Institutions were also assigned values based on rough estimates of their cost.

2. Individual Predisposition to Happiness

We define sociability as one's ability to derive happiness from communities and the people who inhabit them. After money, active social participation is perhaps the most prevalent root of the many variables accounted for in happiness indexes. This indicates that a person's environment and ability to interact with it have a great bearing on happiness.

Additionally, numerous psychologists, including noted subjective well-being specialist Edward Diener, have theorized that all humans are born with an inherent level of happiness that, although subject to short-term fluctuations, in the long term, will always return to a stochastic baseline. This theory is also known as the "hedonic treadmill" and has been supported by studies at the University of Minnesota.

This school of thought led us to use sociability as an indicator of base happiness. Our methodology mixes quantitative and qualitative analysis by surveying the number of community organizations a student participates in, as well as the number of relationships the student has with adults (those no longer in school/not attending), juniors (those younger than them), and peers (those close in age). We then ask the student to rate the value of the organization or relationship to him/herself.

By collecting data in this way, we are able to observe how effective sociability is in fostering happiness in a particular person. Logically, we can equate effectiveness of social interaction to baseline happiness because financial stability leads to a different, more variable happiness than does social ability. Financial stability provides for more basic needs, such as food, water, and shelter, that preclude happiness only because without them one would be dead. Sociability, conversely, leads to a far less black-white (alive-dead) happiness, and it is this supposedly more variable happiness that psychologists believe is actually set at inherent levels.

In conclusion, by using sociability as a measure of baseline happiness, we are in effect measuring how much happiness a student naturally possesses and, consequently, the amount they must attain through financial means. A student with a naturally high base happiness level may be able to deviate from more financially stable paths of study because they do not require as much wealth to be happy.

3. Personal Desires and Goals

The last section serves to compare students' previously demonstrated ability with their future goals. We intend for it to be an indication of students' abilities to undertake the various post-high school educational paths as well as which path is best suited to their monetary needs.

Students' prior ability is determined through two lines of questioning. The first simply asks for a student's grades in school in general and then further distinguishes by academic classes, non-academic classes, STEM classes, and non-STEM classes. The second line of questioning concerns prior workplace performance. It takes into account duration of employment and progression of wage/position. These two lines of questioning are used to identify the area(s) in which a student has thus far showed ability and have the advantage of being entirely quantitative.

Prior ability is supplemented by the final value awarded by the ranking system: personal goals. This section is almost entirely qualitative, but it is only intended to be taken as a rough projection of a student's desired life-path. It also follows two lines of questioning, the first being career goals and the second personal goals.

Summary

A simple way to think of our ranking system is as a means of weighing a student's needs and wants with societal realities. The first step of analysis presents the most logical path, according to easily quantifiable societal standards. The second two steps give the student the opportunity to dodge convention due to varying personal dispositions and goals.

Case Study

In order to further clarify the ranking system, here is a fully annotated example of what undertaking it would entail. In this case study, we follow a student as she completes the system. The student's responses are in red text.

Post-High School Education Opportunities Ranking Test

Student name: Mandy Moody Grade: 12 Date of administration: September

Section 1-Preset Financial Values

Part A-Values from Part II

Note: these are the value rankings we assigned based on our work in part II of the challenge. They are out of 4 and the same for all students.

Calculations: N/A

Section 2-Individual Predisposition to Happiness

1. List any and all community organizations (church groups, volunteer organizations, school-sponsored extracurriculars, etc.) you participate in and rank their influence on your life using the following scale. 1-diminishes happiness, 2-no effect on happiness, 3-creates happiness

	Organization Name	Ranking		
1.	After school bible study	1	2	3
2.	Culinary club	1	2	3
3.	Animal shelter volunteer	1	2	3

2. List any adults (those older than you who have graduated from a postsecondary institution or chosen not to attend) with whom you have a relationship which you consider to be deeper than "acquaintance." Rank them using the previously used scale.

	Adult Name	Ranking		
1.	Mom	1	2	3
2.	Dad	1	2	3
3.	English Teacher	1	2	3

3. List any peers (those of your age or attending postsecondary school) with whom you have a relationship which you consider to be deeper than "acquaintance." Rank them using the previously used scale.

	Adult Name	Ranking		
1.	Best friend since elementary school	1	2	3
2.	Boyfriend of 3 months	1	2	3
3.	Friend in college	1	2	3

4. List any juniors (those younger than you) with whom you have a relationship which you consider to be deeper than "acquaintance." Rank them using the previously used scale.

	Adult Name	Ranking		
1.	Tutoring client	1	2	3
2.	Younger brother	1	2	3
3.	Underclassmen friend	1	2	3

Note: on the real test, there is no limit on how many organizations/adult/peers/juniors may be added.

Calculations: (Total points as marked by student)/(Total possible points given number of organizations and relationships)=Raw sociability score. (Raw score)*2=Weighted score. This weighted score is then added to the standard score of each education option.

Section 3-Personal Desires and Goals

Part A-Academic History

1. Fill out the following table with all your classes and grades from your first three years of high school. Grades should only be "whole" letters; no +/-. Also indicate whether the class was STEM, non-STEM, or non-academic.

	Class Name	Type	Final Grade
1.	English 01	Non-STEM	A
2.	Biology	STEM	B
3.	Algebra 02	STEM	C

4.	French	Non-STEM	B
5.	United States History	Non-STEM	B
6.	Pottery	Non-academic	A
7.	Gym	Non-academic	B

Note: List of classes has been truncated. Actual number of classes listed would typically be between 18 and 24. It is also assumed that there is no possibility of a class that is both STEM and non-academic.

Calculations: Grades are weighted as follows: F=0, D=1, C=2, B=3, A=4. Calculate (Total converted grades)/(Total possible points)=Raw grade score, (Raw grade score)*2=Weighted grade score for all classes, STEM classes, non-STEM classes, and non-academic classes. STEM grade score is added to STEM degree bars, non-STEM grade score is added to non-STEM degree bars, non-academic grade score is added to 2-year degree column (because excellence in non-academic classes indicates an ability to succeed in an academic environment, albeit a less traditional one), and 2-total grade score is added to high school column (the subtraction is done in order to make it so lower grade scores have a greater amount added than higher grade scores, since low grades overall indicate that the student is not predisposed to succeed in academic environments).

Part B-Employment History

2. For how many months have you been 16? ___20___.
3. For how many of the above months have you been employed? ___8___.
4. At how many institutions have you worked? ___2___.
5. How many positions have you held? ___3___.

Calculations: (Months of employment)/(Months student has been 16)=Proportion of months worked (measures agency and motivation to work), (Number of positions held)/(Number of institutions)=Positions per institution (measures ease of promotion and ability to execute numerous roles and learn new skills). (Proportion of months worked)*(Positions per institution)*2=Employment score. If employment score is>2, it is left at 2.

Part C-Future Goals

1. What is your desired age of retirement?
    a. Before 55
    b. Between 56-65
    c. Between 66-75
    d. After 75
2. How many hours do you want to work a week?
    a. 30 or less
    b. Between 31-35
    c. Between 36-40
    d. 41 or more
3. What kind of area do you want to live in?

a. Urban
b. Suburban
c. Rural

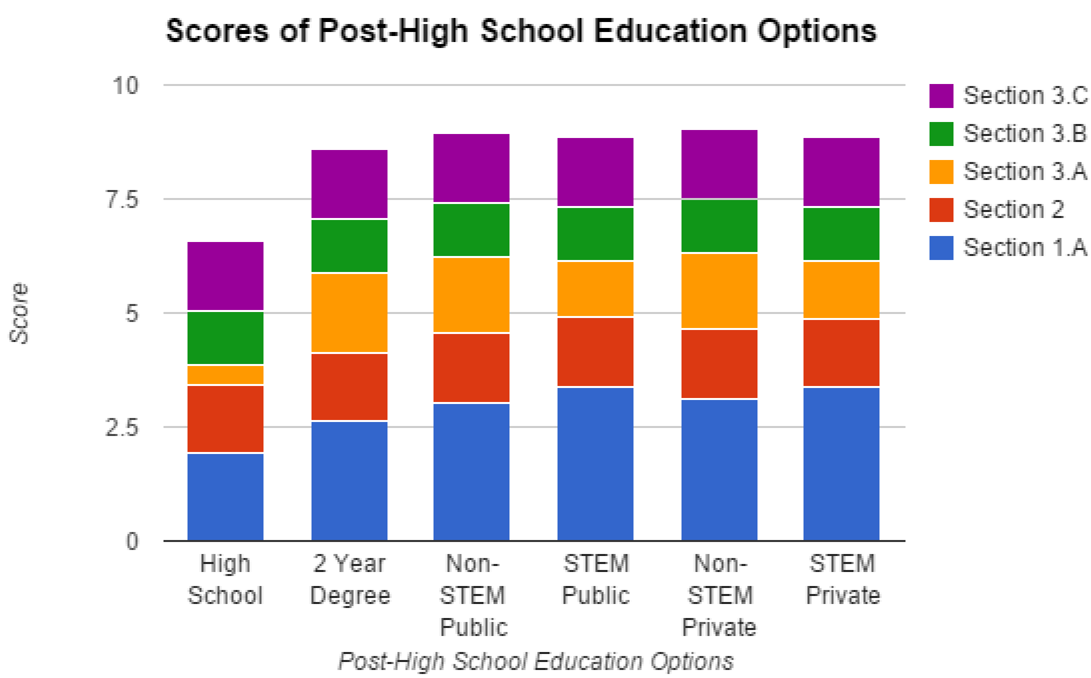
4. How large do you want your household to be (number includes yourself, spouse, children, and any others living with you).

a. 1 person
b. 2 people
c. 3-4 people
d. 5 or more people

Calculations: Every answer (a) is worth 1 point, (b) is 2, (c) is 3, and (d) is 4. Total the student's points and divide by 13 (highest possible score) to get raw goal score. (Raw goal score)*2=Weighted goal score. Add weighted score to all education options.

Results

Ranking: Non-STEM Private (9.042), Non-STEM Public (8.954), STEM Public (8.881), STEM Private (8.875), 2 Year Degree (8.631), High School (6.599)



The above graph depicts Mandy Moody's ranking results. The results are so powerful because they allow students like Mandy to see how their inputs translate to data. Instead of simply spitting out an ordered list of Mandy's best options, the graph allows her to weigh her options. For example, Mandy will observe that a non-STEM private school is her highest ranked option; however, she can also see that her section 2 value is reasonably high, indicating that she is naturally a more happy person and does not necessarily need to follow a recommendation rooted in money. To generalize, this method of data presentation allows students to compare money-based values of their options (which vary among educational options (sections 1 and

3.A)) with their own personal values (which do not vary among educational options (sections 2, 3.B, and 4)).

Conclusion

Based upon our model, higher education is worth the cost in almost all cases. Although, it should be noted that, according to our model, the long-term salary benefits give degrees received from public or private colleges a much higher base ranking than high school or community college degrees. Furthermore, in terms of monetary value, STEM careers rank higher than non-STEM careers. However, ranking of college choices for each individual can vary based on individual personality, skills, and predispositions. This allows the individual high school student to fill out a survey and receive rankings for each degree option. The student can then use the results of our model to best consider all of their post-high school options.

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