



## Using the Education of Engineering Economy to Impact the Reduction of Engineering Student Loan Debt

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## Introduction

The U.S. student debt crisis has become an epidemic over the last two decades [1]. Unfortunately, the epidemic is expanding into the Engineering fields where debt has been traditionally minimized by such pursuits as internships, co-ops, and research projects that were supported by scholarships, fellowship funds, and teaching assistantships. Engineering students expect to make higher incomes than many other majors. That increase in expected earning power may cause students to take out higher loans than they otherwise would have. MK Consulting [1] defines a 10% rule, that the amount of income that is typically needed for paying off this debt within 10 years has been around 10% of the borrowers' income. Anything above this 10% is defined as excessive debt [1]. Assuming an average debt of \$50,000 at an interest rate of 4% for 10 years, these students would need to make payments of \$5,110 per year (\$425 per month). Following the 10% rule they would need to make an annual income of \$51,100. 2008 data from MK Consulting [1] shows that approximately 16.3% of engineering majors graduated with excess debt compared to theology (64.7%), agriculture (34.1%), education (33.9%), and humanities (33.5%) and that these numbers grow each year [1]. This does not include the students who drop out of school and carry debt with them, though they did not earn their degree. Many feel that this excessive borrowing is due to the student's lack of understanding of debt.

Many engineering students are required to take engineering economy, a course in which students must be able to make decisions based on the economic aspects of a problem. In order to do this, students perform financial calculations regarding how money changes value over time, how to affect the rate of change through changes in interest rates, and about financial equivalency and payback. It is thought that these topics make engineering students more aware of how borrowing for college will affect them over time and how they can impact that affect.

Several of the Engineering Economics textbooks utilized in the teaching of the courses highlight borrowing examples including student loan debt calculations. We seek to build on the success of some of these textbooks to standardize an approach that allows for all students to acquire this understanding. This study seeks to investigate the impact that engineering economy courses have on student decisions towards incurring excessive student debt.

This paper suggests that the field of Engineering Economics has an important part to play in this national crisis, and that this study can make an important, positive impact on the field and on this crisis. In this transcript, the research hypothesis, objectives, and methodologies are described in order to invoke the field to participate the Engineering Economics division to participate in this important study.

The main research hypothesis is "that by teaching engineering economic principles in an applied manner that engineering students will gain greater financial literacy, make more informed decisions about borrowing, and will have smaller amounts of student loan debt than without this education." The main objective is to understand the factors that impact engineering students' decisions to borrow money in college.

## Background

There are several contributing factors to student debt that need to be understood in order to comprehend the whole debt crisis. Much like the housing collapse in the late 2000s, the problem is more complex than borrowers simply becoming overextended in their debt.

### State Funding

One of the major focuses on why higher education costs are increasing is the state funding formulas. State funding formulas have changed where states are now paying a lower amount than they did a few decades ago [2]. The way that state funding works is that public universities receive subsidies from the state appropriations, which account for a significant portion of the university funding [3]. In some cases this may be up to 40% of the costs of attending a school with the rest of the costs supported by tuition paid by the student and/or their parents. Federal funding, which many students seek through financial aid, fellowships, and grants, makes up the bulk of student funding to help offset the costs of attending school [4].

State funding occurs through appropriations to institutions, state financial aid for students, and capital expenditures for the institutions [4]. Delaney and Doyle [4], [5], [6], [7] found that states tend to fund institutions better in economically good years and poorly in economically bad years. Both increases and decreases in funding occur at faster rates than other state funding items and introduce volatility in the state formula funding [4]. Much of this volatility occurs and can be explained by the fact that states are required to balance their budgets each year. Higher education is one of the top three costs for most states, following K-12 education and healthcare funding [3]. Because law makers are less likely to drastically cut those two funding sources, they cut higher education funding and add back to it in the economically strong years. Even with this volatility in the state budgets, institutions are ultimately responsible for the affordability of their programs [4].

The volatility is evident in the state funding for fulltime equivalent (FTE) students over the past few decades as shown in Figure 1 [8]. State aid to public universities and grant aid to students has generally been declining since 2001 [10], [8]. This reduction in aid, along with an increase in costs associated with attending a university, has increased the financial burden on students and their parents [10].

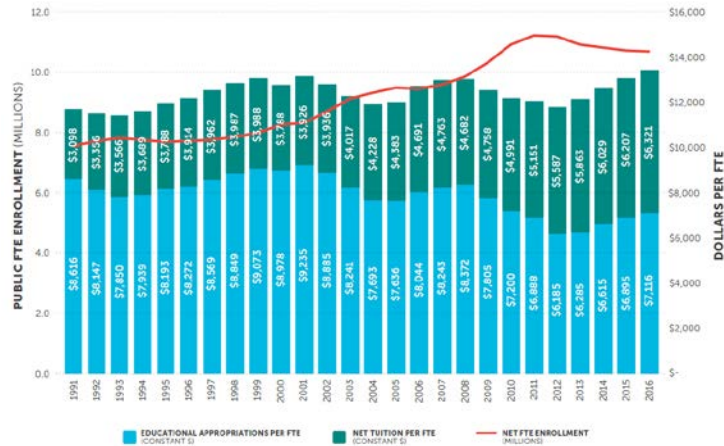


Figure 1: Public FTE Enrollment and Educational Appropriations per FTE, U.S., FY 1991-2016 [8]

### Student Debt

Unfortunately, students find that it is easy to accumulate debt [2]. The amount of debt is staggering, student loan debt currently exceeds credit card debt and auto loans and is closing in on home mortgages debt as one of the top debts in the US [1]. A method for monitoring student debt is the 10% rule, where the amount paid annually on student loans exceeds 10% of a borrower's annual income. What researchers and analysts are finding is that the 10% rule is broken by a significant portion of the population and that portion of the population is growing. In 2008, 34.6% of graduates owed between \$30,000 and \$40,000 in loans and another 34.6% owed in excess of \$40,000 [1]. Many of these graduates will not have the kinds of jobs that will help support this large amount of debt. The end result is that many of these students will not be able to pay off their debt within a decade, which will negatively affect their life activities such as buying a home, buying a car, or getting married [10], [1].

The student debt crisis is readily apparent in total loan values and their increase. In 2013, student loans accounted for an astounding \$1.08 trillion, an increase of almost 70% from 2008 [11]. By 2015, the amount of debt had increased to \$1.2 trillion [12]. Not only is the carried student debt increasing but so is loan default. In 2003 the percentage of default was at 4.5% which increased to 10.0% by 2011 [11]. This means that there is potentially \$120 billion dollars of student debt that is in default. For borrowers, this means that they will continue to carry that debt, even through bankruptcy.

Students tend to be naïve and do not fully understand the somewhat complex financial solutions they have for borrowing money for college [11]. Students also behave more financially illiterate compared to the general population [11], [13]. The problem with this illiteracy is that students are not aware that they have debt, how much debt they have incurred, nor the magnitude of debt that they owe [11]. One bright spot appears in a study performed at Iowa State. In this study, the researchers found that the engineering students there were less likely to not understand their debt compared to other colleges. This understanding was not trivial as over 95% of their engineering students surveyed knew that they had debt and how much they owed [11].

Student debt also affects a student's perception of the worth of their degree, i.e., was it worth earning the degree in the first place [1]. They may feel that the monetary costs, or the hardships endured during the process really were not worth the degree to them. This feeling, that there is a lack of worth about the value of their degree also deters students from pursuing graduate degrees, often since they may still be paying off their debt from a bachelor's degree [1]. This is especially true if it takes them longer than 10 years to pay off their debt.

### Institutional Practices

Institutions have also helped to create the problem with student debt through some of their practices. A study by Monks [9] found that an institution's acceptance and lending practices will affect the debt incurred by a student. In Monks' study, need-blind institutions, or those that do not consider all of a student's costs needs, have a larger impact on the student's debt than if the institution was more in tune with a student's costs needs. There are institutions that do pay greater attention to the student's financial needs and take that into consideration when they accept the student. These institutions have more planning, support, and aid available for their students [9].

One of the responses to the lack of state funding is to increase tuition. For universities, this is one of the methods in which the gap between costs and funding are covered. However, one of the concerns with this is that when the economy is performing poorly, universities typically receive lower funding. The increase in tuition is generally concurrent with an increase in unemployment. Many of these unemployed employees enroll into higher education institutions [3]. The cause for the enrollment increase is that workers are using higher education to increase their worth in the workforce. Unemployed or underemployed students are at a higher risk of incurring more debt. Avery and Turner [14] note this activity in their study as they found that student enrollments have increased regardless of recessions or depressions over the past 30 years, though that increase is not linear. One of the major differences that they showed was that the amount of federal loans offered during the Great Recession grew at a much larger rate than the federal grants provided during this same time period [14].

### The Educator's Standpoint

An important reason to care about the student debt crisis from an educator's standpoint is that the debt a student incurs negatively affects that student's performance [2]. Students are forced to find other means to augment their income so they often work, take out personal loans, and sometimes are forced to leave school for some time period to save money for school. This extends their stay in the university system and puts them at a greater risk of not graduating from their programs [2], [14].

Educators also care that their students do well. It affects the university's prestige by having high performing students who do not carry a high debt after completing their degree that are competitive and sought after in the work force. Having students with high debt impacts many aspects of the university including recruiting, admissions, and the general perception of the university among others. A perception that a particular school burdens a graduate with excessive debt can even cause the federal government to take notice. This has most recently been evident in how for-profit colleges have been handled and portrayed in the media as predatory over the past few years.

## Educating Students on Debt

There are many arguments and discussions on how to best teach students to handle debt and how to finance their education [2]. Some institutions leave it up to the students while many have started to take ownership to help their students understanding more about what debt they could potentially incur while in college. Many students are intimidated by the process while others are indifferent to having debt [10]. Educators and administrators are in a good position to help students and their families, first by teaching how to navigate the processes and second by helping students and their families understand how their debt will affect them in the near term and long term. Educational support can come from informational sources sent to students and parents, financial literacy programs that universities use to support their students, and economics courses that show students how their debt increases over time and how they can positively and negatively affect this debt.

In the engineering fields, one of the more common economics courses is engineering economy. This course teaches students about the time value of money, how to forecast income and expenses, and how to make decisions based on the financial aspects of a problem. Many of the faculty that teach these courses show their students how to run amortization charts, what the impact of making extra payments will have, how negotiating for a better interest rate will change their returns, and how their borrowing for college will affect them over their lifetime. These faculty would feel dumbfounded that any engineering student would claim a lack of knowledge in regards to the time value of money, compound interest, or depreciation. It is also leads the researchers to question whether this is a reason why engineering students appear more cognizant of their debt and more financially literate than many of their counterparts.

## Research Questions and Hypothesis

In this research it is hypothesized that by teaching engineering economic principles in an applied manner that engineering students gain greater financial literacy and make more informed decisions about their debt. The main objective is to understand the factors that impact engineering students' decisions to borrow money in college.

In order to understand this phenomenon better, there are three specific objectives that are investigated:

1. Determine the factors that impact engineering students that cause them to borrow money.
2. Investigate what social-economic and social norms cause students to borrow excessive amounts of debt.
3. Determine what engineering economic principles have the largest impact on these behaviors and ultimately on total debt borrowed.

The proposed test population for this study would be engineering students in the engineering fields who have engineering economy as a course in their curriculum. The authors are hoping to entice ASEE members from the Engineering Economy, Engineering Management, Systems Engineering, and Industrial Engineering Divisions to participate in this study.

The authors seek to introduce a test instrument to be used by engineering economy courses throughout the ASEE divisions that provides insights to student knowledge, perception, and intentions on debt before, during, immediately after the class, and longitudinally until one year after graduation.

This research would be baselined with a test group who will receive additional training about financial literacy in addition to their normal engineering economy class. The test instruments include a questionnaire for students where they define their knowledge of finance, their perceptions of debt, and their intended use for the monies that they borrow during their academic careers. It is envisioned that a mixed model approach can be utilized to reveal information about the engineering students' behavior that can then be used to help modify the behavior of other majors.

#### Proposed Training and Expected Outcomes

The expected results of the model is to increase the students' understanding and financial responsibility in regards to their debt. This will be done by enabling engineering economy faculty with proven tools in which to educate future engineering students to be more responsible with money, and to positively impact the student debt crisis. It is expected that students who have more exposure and higher training levels in the financial tools will make better decisions about their finances.

#### Funding

Students should understand how universities are financed; through state funding, tuition, and grants. Many students should be able to see the links between each funding arm and how they are interconnected. Students at all levels should be educated about the differences between grants, loans, fellowships, and assistantships. Once students understand the differences between these funding types and which funding is available to them then students should know when to borrow and when to go get a job, an internship, or a cooperative experience. All of these funding sources carry different tax implications as well and can affect a student's overall debt.

#### Risk Management

Part of the training should include risk management, where students will be taught how to start up an emergency fund to cover an unexpected hardship such as a layoff, car accident, or medical incident. The hope is that students can build financial stability into their behavior and if things go wrong, they are less likely to have to borrow to get out of that hardship. Risk management should also look at the different types of investments that are made. For example there is typically less risk and a more stable payoff when investing in Certificates of Deposit compared to investing in the stock market. There is the possibility of a larger reward in the stock market but it is more volatile and carries more risk for the investment.

#### Budgeting Basics

The training will also include requiring the students to list all of their credits and debits and how their overall debt affects them. Basically, students should be able to develop a budget for their month to month activities. This will also allow students to understand more about what their real buying power is and what kind of debts they can afford, not just their school loan debts. It also forces student to start justifying and rationalizing their expenses. Students should also be taught

about building their credit score (FICO score) and how it plays into purchasing power and large loan borrowing. Most students don't realize that the credit score is based off of their payment history, how long they have been borrowing, the types of credit they have, debt burden, and their credit inquiries.

#### Expanding Net Worth

The training will deepen to educate students on how to increase their emergency funds to cover 3 to 6 months of their expenses. Students should be able to see how they can spend money on niceties but also continue to put money back to increase their liquid assets, whether through using savings accounts, investing fellowship monies, or just understanding how different money has different tax requirements.

#### Retirement

Though it would seem like their student debt problems should be solved, students should look at their retirement time frame and how they should put money back so that they can retire and still enjoy the financial lifestyle that they hopefully have enjoyed previously. This training should include information on stocks and bonds, how 401k's work, what is an IRA, and what is the potential impact of social security (if it still exists in the future.)

#### Funding for Children

By educating students on how to finance school without going into debt, there should also be an impact on the next generation and how they can secure their children's education. Many of the methods used for some of the other topics work for saving for their children's education. Students should note that once they have some reserves saved up to cover emergencies that they can redirect these funds towards this new requirement.

#### Mortgage and Large Loan Payoffs

Another topic area to concentrate on is the need to be educated on mortgages and large loans and how paying off large loans benefits the borrower. There are difference to the borrower in 15-year and 30-year notes, not only in the length of time but also in the payment amount, the interest rates, and the ability to free up funds for other activities sooner once the loan is paid off. In addition, students need to know about mortgage insurance and how an amortization table works. Even the effect of making extra payments towards the principal should be covered.

#### Wealth and Charity

Lastly, students should be taught about building their wealth and charity. Income affects which tax bracket someone falls into. Depending on how people set up their withholdings and taxes could mean they owe more or less taxes throughout the year. Charity also plays into taxes as it may impact the amount of taxes owed and is a way to help others who may be less fortunate.

#### Initial Study

An initial study looked at graduate students and the impact of engineering economic concept in their studies. It is believed that the proposed study with undergraduate students will have similar results to the study with graduate students. In the initial study, 78 graduate students attended a



training from the Sloan Foundation [15] over financial literacy based on the training described above. Attendees responded to the training through a blog set up to collect the data.

The blog questions submitted by the attendees are generalized into the following responses:

What are the tax implications of scholarships and fellowships?

Is it better to invest your fellowship then borrow money (investment analysis)?

Why is the amount I borrowed a lot less than I received and why do I have to pay much more back for a long time?

How does interest work and what is the difference between compound and simple interest?

How would simple tools like a cash flow diagram make a large impact on debt understanding?

Most of the attendees to the training were PhD students and when this topic was addressed with them they considered the topic Big Data and/or a component of Analytics. They did not initially associate the information presented in the training as required knowledge for paying off a student loan or financing a car or home mortgage.

The results from this training set the basis for the proposed study. There was a vast range of understanding of basic economic principles. The assumption that all engineering PhD's understand these concepts was challenged, as many did not know them or they did not completely understand them. One of the findings from the study was that not all of the PhD's had taken many economics classes in their past curriculum. Many of the engineering PhD's that had more economics courses had more of a background in industrial engineering, engineering management, or systems engineering.

## Conclusions

From the literature, it is evident that engineering students are less likely to accumulate excessive debt while in school. Because of this fact, it is worth examining more in depth what factors tie into why engineering students do not collect this excessive debt. One assumption is that many engineering students do some form of internship, co-operative, or part time work. Student loans, if understood in the context of engineering economy, could impact student behaviors

Engineering economy has changed over time, mostly for the better, though there are some traditional activities that should remain. Much of how engineering economy is taught is based on the calculations. Because students work many of the problems out by hand, they understand the mechanism better and how they can affect or drive the end result. This is one of the features of engineering economy and why the researchers focused on this course. Unlike many other finance and accounting classes, engineering economy requires the student to utilize the solution of the problem to make a decision, something that cannot be accomplished by simply plugging the

problem into a computer or calculator. Cash flow diagrams, basic hand calculations, and the iterative way that engineering economy is traditionally taught allows the student to kinesthetically feel the interest they are paying.

Older engineering economy texts address depreciation and taxes which gives the same flavor that new government regulations may have on debt payments. Complications in the problems are reminiscent of real problems, such as financing a combine or tractor, and is similar to paying student loans.

This paper discusses a proposed study on the effects of engineering economics and student loan debt. The paper proposes topic areas in engineering economy and shows how these topic areas were used in an initial study on PhD students. The research shows that not all PhD students have the expected financial understanding even though they were pursuing PhD's in engineering. It is believed that the study on undergraduate students will yield more benefit and help tackle the mounting student loan debt in the US.

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