Benefit-Cost Analysis of

Critical Reading Emphasis

in STEM Courses at

Florida Polytechnic University

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# Abstract

It has been found that students at Florida Polytechnic University may benefit from improving their critical reading skills. The purpose of this study was to evaluate if an emphasis on critical reading skills should be implemented in courses at Florida Poly to enhance students’ employability or continued education post-graduation by performing a Benefit-Cost Analysis in order to determine what value this would bring to students. A survey of faculty and a series of analyses were conducted through the Office of Institutional Research, and it was discovered that the present value gained per student over their lifetime exceeded $38,042.66. Thus, it was decided that an emphasis on critical reading skills should be implemented in courses at Florida Polytechnic University.

Benefit-Cost Analysis Project Report

ECP 4031 | Dr. J. Dewey

December 8, 2021

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# Executive Summary

In this project, our goal is to analyze the benefits and costs of introducing an emphasis on critical reading skills in courses Florida Polytechnic University to enhance students’ critical reading skills. According to our sample, 55.5% of faculty agree that an emphasis on critical reading is very likely to significantly benefit Florida poly students. These findings present a need at Florida Polytechnic University for our classes to focus more on developing critical reading skills. Evidence suggests that this may significantly increase Florida Poly students’ success in employability or continued education in their post-graduation endeavors.

To test these claims, a benefit-cost analysis was conducted that aimed to reveal how valuable implementing more critical reading in Florida Poly’s courses would be. The first step in our benefit-cost analysis was to conduct a survey of faculty members at Florida Polytechnic University. This survey asked professors to rate their student’s perceived critical reading skills and their perception of their student’s motivation to improve their skills.

The results of the survey yielded a baseline of where students fall in terms of their critical reading abilities. These findings were then able to be quantified and estimates of the probabilities of improving their skills were obtained. Next, an analysis was conducted based off of the estimates from our survey that speculated at the benefits received over the lifetime of students and costs incurred to Florida Polytechnic University for emphasizing the development of critical reading skills in STEM courses at Florida Poly.

The results of our analysis revealed that the net benefits to be gained resulted to approximately $3,321,155.64 for all students or about a $1,843.79 individual benefit to each student. Due to the undeniable benefits that could be available to students by simply focusing more on critical reading skills at Florida Polytechnic University, our analysis suggests that the university should consider adjusting the course curriculum to reap these benefits.

# Introduction

It appears that STEM students at Florida Polytechnic University seem to be lacking in the development of their critical reading skills. Critical reading skills are essential to students among all disciplines to develop their literacy and proficiency in their discipline and form their own arguments on various topics. This presents a challenge to students looking to analyze complex texts or just to simply parse texts for increased comprehension. Outside of college, possessing good critical reading skills can mean the difference between landing a job or not. According to Newman University, the top skills that employers look for are critical thinking and problem-solving skills (Campbell, 2021). These findings present a need for a more focused approach to improving student’s critical reading skills at Florida Polytechnic University. Since critical reading should be applied across a range of studies and disciplines in student’s daily lives, I believe the best way to address this could be met by integrating a course requirement to develop more critical reading skills in Florida Polytechnic University’s classes.

Certain classes at Florida Polytechnic University focus on developing these skills through critical reading exercises outside the class and follow-up discussions about the readings in class. However, these critical reading exercises are not required or emphasized in every class. We believe that this would be a valuable addition to Florida Poly’s curriculum because engineers and analysts need these skills to develop their literacy and proficiency in their discipline and form their own arguments on various topics.

# Literature Review

There appears to be a consensus among researchers, university faculty, and students, that critical reading is significantly useful and applicable to all levels of education. However, it's not as present as comparable tools in a student's toolbox they develop over their time as university students, specifically undergraduate studies.

According to Shostya and Morreale, “Critical reading is fundamental to studying economics … developing critical reading and thinking skills can make students more economics literate, and thus more proficient in economic principles, economic theory, and economic policymaking” (Shostya, 2020). it is important that students develop critical thinking skills to succeed not only in college, but in the workplace, and in life. I thought this was interesting because it addresses similar concerns as were noticed in our Contemporary Economic Issues course (ECO 3930) that economics students struggle to parse complex texts.

Though students are confident in their abilities to read and write as they go into their freshman year, they're shortsighted in their perception of their ability to create strong arguments. Booth makes a point in saying that “University history departments are concerned about the limitations of undergraduates in their construction of arguments and their critical reading skills … Students beginning university are generally confident of their ability to write essays, take notes from textbooks and work independently. By the end of their first year at university, undergraduates' understanding of what the study of history entails has changed dramatically. If teachers at school and university level can find ways to ease this transition, then surely this will enable further progression” (Booth, 2005). Booth continues with explaining that students are much more confident in their ability to collect information than in their ability to make arguments in great depth.

Campbell furthers the argument that critical reading and critical thinking are supplementary by saying “Employees need to be able to analyze evidence, question assumptions, test hypotheses, observe and draw conclusions from any form of data. Critical thinking is not just a skill, but a habit formed to help with problem-solving” (Campbell, 2021).

Norwood and Henneberry focus on critical reading skills in the workplace. Their paper states that employers are willing to pay for specific intangible competencies such as critical thinking and communication skills. (Norwood & Henneberry, 2006).

Kulkarni, Anuttama, and Vartak examine the specific benefits of critical reading and potential reasons why it hasn’t been as popular thus far among undergraduate courses. Traditionally, reading scientific literature has not been introduced in university until the end of or after undergraduate studies because “reading and comprehending a good piece of primary literature requires considerable background knowledge that includes familiarity with experimental techniques, statistical methods, and expert terminologies” (Kulkarni, 2019). However, the arguments in favor of undergraduate students being given primary sources from industry researchers include enhancing students' understanding of the process of scientific inquiry, appreciating the methodological work that goes into making a piece of primary science literature, and humanizing the view of science and scientists, making students aware of the effort, debates, and excitement the scientific community goes through before a scientific theory is established (Kulkarni, 2019)

# Data

We collected our data by working with Florida Polytechnic University Institutional Research in order to conduct a faculty survey. This survey contained nine questions ranging from demographic identifiers to free response, to Likert scale-based questions in order to collect relevant data. The first question we asked was if the professor was full-time or part-time. From the survey responses, we could see that 82.22% of the faculty surveyed in this sample were full-time professors and 17.78% of those surveyed were part-time professors. For the second question, we asked professors if their students practice critical reading skills in their courses according to our definition of critical reading. Results from this question were interesting as it was a perfect 50/50 split. 27 faculty members stated that students use critical reading skills in their classes and 27 faculty members reported that students do not. The following question asked professors in what way is critical reading present in their courses. Most professors reported that students practiced critical reading in projects, outside of class, or in the laboratory. The next question asked if students were given a subject-related publication, what percentage of them would be able to critically read and understand different levels of details in the text. The result from this question tells us that, according to professor’s observations of their students, on average about 19% of students were considered to able to understand “most, if not all of the important details of a publication”, 49.7% of students would be able to understand “a moderate amount of the important details”, and 31.3% of students would understand “none, or almost none, of the important details”.

Questions six and seven asked professors to estimate the probability a student at a lower critical reading level improving to a higher critical reading level. Excluding entries that were blank or non-percentage values, Professor’s estimated 44.9% of students at a moderate critical reading level “might improve to an excellent critical reading skill level” and 32.7% of students at a poor critical reading level “might improve to at least a moderate critical reading skill level”.

After getting an estimate of the percentage of students who show potential to improve, question 8 asked Professors how likely an increased emphasis on critical reading would significantly benefit Florida Poly students. Out of thirty-eight responses to this question, three thought it was “very unlikely”, one thought it was “somewhat unlikely”, six thought it was “neither likely nor unlikely”, eight thought it was “somewhat unlikely”, and twenty thought it was “very likely” that an increased emphasis on critical reading would significantly benefit Florida Poly students.

In contrast to the numerical-based responses thus far, question nine received qualitative responses. The question “How [do] you think an emphasis on critical reading would affect students’ employability or continued education post-graduation” was proposed to professors. It would be redundant to list how many responses were negative, neutral, or positive because they unsurprisingly proportionally followed suit to question eight. A large majority of responses were undoubtedly positive with only a few responses neutral or prioritizing increasing an emphasis on critical reading lower than sticking with the status quo. Out of thirty-seven responses, two were effectively similar to “it depends”, one claimed that students already practice critical reading skills. Two solely mentioned it would improve employability, two claimed it would useful, if not critical, to succeeding in a higher education program (such as a masters or PhD program) and eleven claimed it would be significantly useful in both paths. Three claimed something similar to the idea that abilities other than technical skills are as important if not more important, two claimed critical reading skill development could improve abilities in other areas and twelve responses were simply in favor of an increased emphasis of critical reading practice throughout Florida Poly. Some notable examples of answers include:

* *"It is absolutely essential that we emphasize critical thinking to our students. We claim to produce learners and engineers, not someone who can just do what they are told to do."*
* *"It could indirectly help by getting students more involved in activities that require critical reading, like research and competitions"*
* *"I believe concepts and implementation are more important than cutting edge theoretical knowledge. Critical reading is important but not as high of a*
* *priority as being able to use existing knowledge."*

The Fall 2021 Profile published by Florida Polytechnic University that provided information on the demographics of the university including the number of freshmen enrolled at that time which was used in this analysis. The next source we referenced was the course textbook (Boardman et. Al) which provided information on the real discount rate. Next, the article discussed in our Contemporary Economic Issues class on “The Demise of U.S. Economic Growth: Restatement, Rebuttal, and Reflections” written by Robert Gordon was used to determine the value used for the growth rate. Lastly, unable to find an exact monetary value for the value of critical reading skills in terms of employability and continued education, we created an estimate based off what we know from our faculty survey and the value of similar skills such as critical thinking. According to a report from 2015, employers would pay approximately $7,745 more for candidates with “evidence of problem-solving and critical thinking skills,” thus, this will be used as an estimate for the impacts of critical reading skills in this analysis.

The Fall 2021 Profile published by Florida Polytechnic University that provided information on the demographics of the university including the number of freshmen enrolled at that time which was used in this analysis. The next source we referenced was the course textbook (Boardman et. Al) which provided information on the real discount rate. Next, the article discussed in our Contemporary Economic Issues class on “The Demise of U.S. Economic Growth: Restatement, Rebuttal, and Reflections” written by Robert Gordon was used to determine the value used for the growth rate. Lastly, unable to find an exact monetary value for the value of critical reading skills in terms of employability and continued education, we created an estimate based off what we know from our faculty survey and the value of similar skills such as critical thinking. The article by AlphaBeta valued for critical thinking and problem-solving skills of $7,745 which we will use as an estimate for the impacts of critical reading skills in this analysis. Finally, the university would develop an emphasis on critical reading abilities into existing curriculums. Costs incurred would include the time spent developing what an ideal exposure and practice of critical reading would look like and the time lost in class which would have been spent on lectures or working through examples. The equation used to calculate the total costs and the variable definitions are below.

From this data, an analysis will be conducted to reveal the benefits to the students over their lifetime for introducing more critical reading into their courses and the costs incurred by Florida Polytechnic University to revise course curriculums and train professors to tailor their classes to focus more on developing their student’s critical reading skills.

# Analysis

For this analysis, we will be conducting a benefit-cost analysis to estimate and weigh the net monetary benefits and costs of integrating a course requirement to enhance the critical reading skills of students at Florida Polytechnic University. More specifically, we will be focusing on estimating the probability of increasing these student’s critical reading skills to quantify the impact of implementing a critical reading course requirement. To accomplish this, the following variables were considered from the survey data collected.

|  |  |  |
| --- | --- | --- |
|  | # of students enrolled (fall 2021) | 1562 |
|  | Real discount rate | .035 |
|  | Growth rate | .015 |
|  | # of students classified as possessing moderate critical reading skills | 674 |
|  | probability of a student improving from moderate to excellent critical reading skills | 0.3455 |
|  | Benefits, per student, of improving from moderate to excellent critical reading skills | $7,745 |
|  | # of students classified as possessing poor critical reading skills | 423 |
|  | probability of a student improving from poor to moderate critical reading skills | 0.3273 |
|  | Benefits, per student, of improving from poor to at least moderate critical reading skills | $3872.5 |
|  | Total cost per credit hour | $164.58 |
|  | Time (in hours) spent on critical reading-related material in class | 12 |

Table 1

To begin, we sought to determine the benefits to students who possessed excellent critical reading skills. According to our research, we have estimated the value that employers would pay for candidates with excellent critical reading skills as an additional $7,745 per year (AlphaBeta). We assumed that students with excellent critical reading skills would receive the full $7,745 annual benefit and students who were classified as possessing moderate or poor critical reading skills would receive a fraction of that benefit. That is, if the individual possesses moderate critical reading skills, they would receive half of that benefit at $3872.5 and individuals with poor critical reading skills would receive no additional benefits. The benefits of improving their skill set from poor to moderate critical reading skills can be calculated as seen below.

*Bpm = $3872.5 – 0 = $3872.5*

The number of students who fell into each category of critical reading skills was obtained by multiplying the total number of students at Florida Polytechnic University in Fall of 2021 (Fall 2021 Profile) by the percentage of students who fell into each critical reading category according to professors. For example, the survey showed that 43.13% of students fell into the moderate critical reader category and 27.11% of their students fell into the poor critical reader category. The following are the total number of critical readers considered to have moderate and poor critical reading skills

*Total number of students with moderate critical reading skills:*

*Total number of students with poor critical reading skills:*

Next, the probability of a student improving to another skill level was then found by multiplying the percentage of students, that professors believed displayed motivation to improve to a certain skill level, by the percentage of students in that category. For example, 8.82% of professors thought that about 75% of their students could improve from moderate to excellent, 20.59% thought that about half of their students could improve from moderate to excellent, 70.58% of professors thought that about 25% of their students could improve from moderate to excellent, and 1% thought that almost none of their students could improve from moderate to excellent. Therefore, the probability of a student moving from moderate to excellent was calculated as

*𝑓m𝑒 = (0.0882)(0.75) + (0.2059)(0.5) + (0.7058)(0.25) + (0.01)(0) = 0.3455*

After calculating all of the above variables, we were able to estimate the total benefits per student as seen in the equation below.

*Total benefits per student:*

After the individual benefits per student were calculated, the net present value (NPV) was estimated by discounting the benefits that each student received over the lifetime of their career and the benefits were summed up. This value was then subtracted by the cost of implementing more critical reading into the curriculum and multiplied by the number of courses offered at Florida Polytechnic University.

*Total lifetime benefits per student:*

*Net Present Value of the total lifetime benefits per student:*

|  |  |  |
| --- | --- | --- |
|  | The average number of years that graduates are expected to work over the lifetime of their career | 47 |
|  | The total benefits per student over the lifetime of their career | $86,658.27 |
|  | Growth rate | .015 |
|  | Real discount rate | .035 |
|  | Cost of lost class time (per class) | $131.20 |
|  | The number of courses offered at Florida Poly | 457 |

Table 2

As seen above, the NPV function models the total benefits for each student over the lifetime of their career. According to “The Demise of U.S. Economic Growth: Restatement, Rebuttal, and Reflections” by Robert Gordon, the growth rate constant is 0.015. According to the course textbook, the real discount rate is 0.035. Each of these constants were utilized to put the money into present value. The cost of lost class time was estimated by multiplying the number of classes offered at Florida Poly by the estimated product of time spent on critical reading in the classroom and the cost per hour of class time. The cost per hour of class time was calculated by dividing the cost per credit hour by the number of weeks of school in a semester. We had to make this conversion because there is a difference between cost per credit hour and cost per hour of class time. Credit hours is a measure of time spent in class in a single week.

The cost of lost class time was estimated by:

|  |  |  |
| --- | --- | --- |
|  | Cost of lost class time spent on critical reading | $59,958.40 |
|  | Cost of an hour of class time | $10.93 |
|  | Time spent on critical reading | 12 |
|  | # of courses offered at Florida Poly | 457 |

Table

The cost of class time is:

|  |  |  |
| --- | --- | --- |
|  | Cost of an hour of class time (S) | $10.93 |
|  | Cost per credit hour ($) | $164 |
|  | Weeks of class in a semester | 15 |

Table 4

After obtaining all of these variables and performing the calculations, it was found that the benefit to each student was $1,843.79 while the cost of lost class time was estimated to be $59,958.40. The overall net present value of implementing a critical reading emphasis in courses at Florida Polytechnic University is *$38,042.66*. Lastly, the benefits received by each student over the lifetime of their career was estimated to be $86,658.27.

## Sensitivity Analysis

Next, a sensitivity analysis was performed in order to test the robustness of our data collected by the survey. Sensitivity analysis allows us to see how much the parameters of the study could change before the overall recommendation changes. Furthermore, sensitivity analysis is important in determining how much of an impact it would have on the conclusions of this analysis if the data used from our survey turned out to be inaccurate. To accomplish this, each of the probabilities used to estimate the benefits and net present value were adjusted by applying a uncertainly factor to observe how the results would change. With this in mid, our analysis revealed that the total benefits received by each student are not highly impacted by changes in the probability. Thus, our results were not highly sensitive to changes in these parameters should the estimates obtained from our surveys be slightly inaccurate. Furthermore, we were able to rule out the value of the time lost in the classroom because small variances in this value depending on the time that professors choose to spend on critical reading exercises in the classroom on would not result in a large impact on the overall costs.

# Discussion

Not surprisingly, the potential benefits likely to be realized by students over the course of their career vastly outweigh the costs incurred to the university. After attending Florida Polytechnic, we estimate that simply adding a noticeable emphasis on critical reading within applicable courses at Florida Polytechnic would increase graduates career earnings by $86,658.27 or about $1,843.79 per student while only incurring the cost of class time lost at $59,958.40 per semester. Class time lost is the product of the cost of one hour of class time in the 2021 fall semester and the 12 hours spent on critical reading practice during the semester. Class time lost is simply the time sacrificed by practicing critical reading instead of what would be studied if an emphasis on critical reading hadn't been developed into the curriculum.

The narrow perspective of this analysis undeniably warrants lengthy future discussions and considerations. For examples, the costs incurred by the university depend on how the university would like to approach their strategy of developing a greater emphasis on critical reading into their curriculum. We believe a realistic and rational strategy is one where the students benefit as much as possible and the university spends as efficiently as possible. We ultimately decided on the aforementioned approach, however, what if instead of working critical reading exercises into existing curriculum, Florida Poly added an entirely new course for students to take, probably for freshmen but it could just as well benefit graduate students. Or rather, leaving the decision up to the professors but informing them via email of best practices, the potential benefits, and providing general encouragement of/toward critical reading.

Going forward, our work could and should be used to provide a baseline for the equations necessary to conduct appropriate analysis of the data in the survey as well as serve as the justification for continued study of the potential net benefits of an increased emphasis on critical reading throughout Florida Polytechnic University.

# Conclusion

In conclusion, our analysis suggests that the net benefits of implementing a critical reading emphasis in STEM courses at Florida Polytechnic University outweigh the costs. As a result, our team recommends that the university considers making the appropriate adjustments to course curriculum so students may reap the benefits, for now and for the future of this valuable addition to their education at Florida Poly. Our analysis found that the net benefits that could be gained by the collective student body resulted to approximately $3,321,155.64. This calculates to about a $1,843.79 individual benefit to each student currently enrolled at the university. Looking at graduates’ lives post-graduation, implementing a critical reading emphasis in these courses correlates to a total lifetime benefit over graduate’s careers equal to $86,658.27. This is because employers highly value the skillset of possessing excellent critical reading skills in the workforce. According to our faculty survey, critical reading is clearly an underdeveloped skillset in STEM based courses at Florida Poly. This opens lots of opportunities for growth to benefit students and enrich the education foundations developed at this university.

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# Appendix A Survey Questions



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# Appendix B Survey Responses

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