Combining Financial Education with Mathematics Coursework: Findings from a Pilot Study

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Abstract: Recent research has shown that two forms of education intervention significantly improve financial outcomes: rigorous, in-depth personal finance courses and additional mathematics coursework. This suggests that a mathematics course that offered systematic, in-depth applications to personal finance could be particularly effective.

In this paper, we summarize the results from a pilot of such a course, and demonstrate how it is motivated by recent literature, despite being a type of course that has so far not been studied thoroughly. We then present the results of our preliminary impact assessment, and show how financial knowledge and confidence improve significantly after taking the course. We discuss how this indicates that such an approach is a promising strategy for improving financial outcomes.

Keywords: financial literacy; financial education; financial outcomes; mathematics coursework; spreadsheets.

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1. Current State of Financial Education

Current research has demonstrated the precarious financial position of a large proportion of Americans, and the pressing need for improved financial decision making, particularly among young people: "Young adults in the United States are heavily reliant on debt, and their level of financial literacy is low" (M. Brown et al., 2016). As Urban et al (2015) point out, young adults are a group that research shows have particularly low levels of financial literacy (Lusardi et al., 2010), and further, as a group, they are prone to engage in various financially detrimental behaviors surrounding credit, such as using payday loans, paying interest on credit card balances, and accruing late fees (FINRA Foundation, 2013). These results are not surprising, given the fact that most high-school and undergraduate students fail basic financial literacy tests (Hastings, Madrian, and Skimmyhorn, 2013; Markow and Bagnaschi, 2005; Shim et al., 2010).

Relatedly, it is well-documented that a lack of financial knowledge – also known as 'financial literacy' – is strongly correlated with poor financial decision making, and that improving a person's financial knowledge may improve his or her decision making. Specifically, individuals with lower levels of financial literacy tend to have lower levels of planning for retirement, lower levels of retirement savings, and less asset accumulation, along with higher levels of debt, and higher likelihood of using alternative financial services (Lusardi and Mitchell, 2007, 2014; Lusardi, Mitchell and Curto, 2010; M. Brown et al., 2016).

Conversely, there is a strong relationship between high levels of financial literacy and a higher probability that individuals will budget their spending appropriately, pay bills on time in full, track expenses, save each month, maintain an emergency fund, diversify investments, and

set financial goals (Hilgert and Hogarth, 2003; Lusardi and Mitchell, 2014). In general, there is a substantial body of knowledge linking high levels of financial literacy with various beneficial financial practices and behaviors, and low levels of financial literacy with detrimental practices and behaviors (Hastings et al., 2012). While many of these papers focus on the United States, a brief review of the research suggests this may not only be a domestic problem. For instance, Navickas (2013) has found similarly troubling findings among young people in Lithuania.

In light of these findings, policy makers at the national, state, and local levels have pushed for a greater emphasis on financial literacy in compulsory education, hoping that providing more financial education will improve financial knowledge, and, in turn, improve financial outcomes. This has led to the growth of a range of financial education programs across the county: from state-mandated high school courses, to on-the-job training sessions (Council for Economic Education, 2016). Despite this, the evidence in favor of financial education has been mixed.

While the aforementioned research has shown positive correlations between levels of *financial literacy* and beneficial financial outcomes, it has been challenging to show conclusively that *financial literacy education intervention* improves either financial knowledge or financial outcomes. Fernandes et al. (2013) showed that measured financial literacy can make significant predictions regarding later financial behavior; however, they found that financial education interventions intended to improve later financial behavior were largely ineffective, with a statistically significant but minuscule effect. Cole et al. (2014) found similar results across a range of states:

> [R]equiring high school students to take personal finance courses had no effect on investment or credit management outcomes, such as: probability of reporting any investment income, the level of investment income, credit score, credit card delinquency or the probability of bankruptcy or foreclosure. Nor do these mandates have a detectable effect on total financial assets or real estate equity. (p. 2)

Without conclusive research showing a causal relationship, it may be difficult for schools and policy makers to justify further increasing the amount of time schools devote to financial literacy, as there are significant opportunity costs in doing so (Fernandes et al., 2013). Providing financial literacy education and devoting school resources, teachers, and student class time to financial literacy requires that schools supplant other activities and courses (A. Brown et al., 2016).

This does not mean that expanding financial education is a misguided project. Not all financial education interventions are equally effective. Though much of the literature discusses financial education in general, the interventions used across the U.S. vary greatly: they range from weekend trainings to full-year academic courses. The effects of an 8-hour training program likely differ from the effects of a yearlong course (M. Brown et al., 2016).

With new state-mandated high school courses being taught across the country, researchers have had the opportunity to begin to differentiate between interventions. By looking at different state programs individually, Urban et al. (2015) found that more rigorous state mandates for education in financial literacy had a greater effect on subsequent financial wellbeing. There were improved credit scores and reduced delinquency rates for young adults in states with rigorous state mandates, relative to those states that had less rigorous mandates, or none at all. While there are conflicting findings regarding financial education in general, rigorous in-depth financial literacy courses have been shown to be effective in improving financial wellbeing (M. Brown et al., 2016; Urban et al., 2015).

In light of these findings, it is of particular note that the literature shows that additional courses in *mathematics* improve later financial outcomes. Such coursework has been shown to improve creditworthiness, decreases adverse financial outcomes, lead to significant positive impacts on issues related to student debt, increase the propensity to accumulate assets, increase the propensity to accumulate real estate equity, reduce credit card delinquency and reduce the probability of experiencing foreclosure (M. Brown et al., 2016; Cole et al., 2014). This makes sense since, as Hastings et al. (2012) note, there is a well-documented relationship between numeracy, and related cognitive abilities, and financial outcomes. Individuals with such attributes tend to have higher levels of financial literacy (Banks and Oldfield, 2007; Gerardi et al., 2010). Further, a study by Cole (2016) found that "additional mathematics training leads to greater financial market participation, investment income, and better credit management, including fewer foreclosures."

Given the need for improved financial decision making, particularly among young people, this research suggests that a rigorous course that combines personal finance and mathematics is a promising approach to financial education. The conceptual knowledge behind personal finance and the conceptual knowledge behind the related mathematics are mutually reinforcing.

2. Methods & Course Design

The literature review suggests that the ideal form of financial education would be a mathematics course that provides systematic applications to the key topics in personal finance. This would leverage the financial benefits of additional mathematics coursework, while also delivering the kind of rigorous education in personal finance that has proved most effective.

Such a course is analogous to a physics course that applies mathematics to scientific topics. It has the added benefit of reducing the opportunity cost identified by Fernandes et al. (2013). Alongside any financial benefits, students would be receiving education in Common Core aligned mathematics, which is independently beneficial and typically required in schools anyway.

Surprisingly, there is little existing research on the effectiveness of a course that combines personal finance and mathematics. Therefore, we set out to design such a course ourselves and explore its effectiveness.

Since we set out to design a mathematics course, we first consulted the research surrounding recent trends, findings, and best practices in mathematics education. We determined that our course should be conceptually-focused and project-based, make use of appropriate technology, make connections to the real-world, attend to the development of quantitative literacy, and be well-suited for delivery in a student-centered fashion (Lester, 2007; National Council of Mathematics Teachers [NCTM], 2000; National Governors Association Center for Best Practices, 2010). In addition, we determined it self-evident that the course should also deliver practical mathematical and personal finance skills.

In order to present the personal finance topics in a rigorous, conceptually-focused manner, we structured the sequence of study around the idea of the 'financial life cycle.' This is the Nobel Prize winning theory that one's financial needs and abilities vary over the course of one's lifetime, and one must plan for this when making financial decisions: this requires transferring consumption over time and managing risk (Deaton, 2005; Ibbotson et al., 2007). Fully exploring the concept of the financial life cycle requires working through the fundamental topics in personal finance (Jumpstart, 2015) in a unified sequence that reveals their conceptual

underpinnings. It also requires utilizing mathematical concepts and techniques of increasing complexity throughout the course to enrich student understanding of the financial topics. We named the course ‘FiCycle,: Financial Life Cycle Mathematics.’

The mathematical content of the course was selected specifically to support the personal finance content, and covers topics from Common Core State Standards for Algebra, Statistics and Probability, and Modeling, but is primarily rooted in algebra.

Informed by best practices in mathematics education, the course is project-based: our goal is to make sure students learn to apply the material in real life scenarios and use mathematics in combination with critical decision making. Each unit has a final project as its primary summative assessment which requires students to exhibit both quantitative and financial literacy. Most projects in the course present a description of a character facing a particular financial problem. Students must analyze this situation and advise the character on what they should do, while making the necessary mathematical calculations to help formulate and back up their advice. The structure of the units is designed to build towards these final projects. There are few correct or incorrect answers; rather, students use mathematics and their knowledge of financial instruments to make informed decisions and give advice, using mathematics as their evidence.

The course contains six units:

- **Unit 1: Financial Statements** – Students learn about wealth by creating a balance sheet as well as a budget.
- **Unit 2: Earning Interest** – Students learn how transferring money to the future increases value through compounding.

- **Unit 3: Regular Payments** – Students learn the mathematics underlying regular cash flows such as mortgages and retirement savings.
- **Unit 4: Insurance and Expected Value** – Students are introduced to risk and making decisions in the face of uncertainty.
- **Unit 5: Stocks and Risk** – Students learn about the stock market, with a focus on the efficient market hypothesis and the statistics related to diversified and systematic risk.
- **Unit 6: The Role of Government** – Students gain an understanding of the government's role in shaping the environment in which individuals make financial decisions.

The identification of algebra as one of the primary mathematical topics addressed, and the practical skills required for effective financial decision making, led us to incorporate systematic use of spreadsheet software into the course. Spreadsheets have long been seen as a valuable tool in mathematics education. As Friedlander (1998) articulates:

> Spreadsheets build an ideal bridge between arithmetic and algebra and allow the student free movement between the two worlds. Students look for patterns, construct algebraic expressions, generalize concepts, justify conjectures, and establish the equivalence of two models as intrinsic and meaningful needs rather than as arbitrary requirements posed by the teacher. (p. 2)

Both the Common Core State Standards (2010) and the National Council of Teachers of Mathematics' Principals and Standards for School Mathematics (2000) advocate for the strategic use of technology in mathematics classrooms. NCTM cites the use of technology as, "essential in teaching and learning mathematics," specifically referencing spreadsheet software as a way to represent mathematical ideas in a different form.

Research backs up these recommendations, as it shows that strategic use of technology strengthens mathematics teaching and improves student learning (Dick and Hollebrands, 2011).

Students who work with spreadsheets in mathematics activities have significantly higher self-efficacy for algebra than those who received conventional instruction, and we know that self-efficacy predicts academic achievement across all academic subjects and levels (Topcu, 2011).

In the course, spreadsheets are used as a mechanism for demonstrating important mathematical concepts such as functions, recursion, and variables. In addition, use of spreadsheet software provides training in the application of spreadsheets to financial problems, which gives students an important skill for many careers, and for managing their own finances effectively.

This course was intended as a mathematics course, to be taught by a mathematics teacher. We believed that a mathematics teacher would be best positioned to cover the curriculum in the rigorous mathematically grounded way, that previous research suggests is the most effective form of financial education. As the next section will discuss, the course materials were developed with this teaching context in mind.

3. Course Pilot

In the 2016-2017 school year, FiCycle piloted in three urban New York City high schools. It was taught as a year-long mathematics elective for juniors and seniors. The students taking the course had all passed the New York State Algebra I Regents Exam and had some additional mathematical experience, but were not on the calculus track. The goal of the pilot was to observe the course materials in action, gather data, and get feedback from teachers and students in order to improve the materials and support our efforts. We were interested to see how teachers and students responded to the material and to acquire the information necessary to plan for an expanded rollout.

We found the pilot schools through personal contacts and other educators we met while developing the course. The one stipulation we required from schools was that FiCycle would be offered as a mathematics class and taught by a mathematics teacher. We worked with a small number of schools so that we could develop a personal relationship with the pilot teachers and gather both quantitative and qualitative data to help measure the effectiveness of the course and to aid us in making improvements and modifications for the future.

The three pilot schools' names have been omitted from this paper, but we have provided accurate descriptions of three schools below:

- Pilot School #1: A public school that specializes in the arts. This school taught FiCycle in two year-long classes, with approximately 30 students. Students at this school were a mixture of juniors and seniors who had taken mathematics classes through Algebra 2.
- Pilot School #2: A public charter school in the Bronx. This school taught FiCycle in one year-long class, with approximately 15 students. Students at this school were a mixture of juniors and seniors who had taken mathematics classes through Geometry.
- Pilot School #3: A public school in the Lower East Side of Manhattan. This school taught FiCycle in two semester-long classes, with approximately 25 students. Students at this school were a mixture of juniors and seniors who had taken Algebra I and Geometry.

To assist teachers with taking on a new, unfamiliar course, we offered two full-day training sessions in the summer prior to the pilot. During this time, we introduced attendees to the broad outline of the course, the structure and location of the materials, and worked through key topics in the first two units. When creating the materials, we assumed the teachers had no prior financial knowledge and made sure to provide explanations of all financial topics and vocabulary that the course covered. We developed a teaching companion document, which was intended to

introduce the teacher to the financial concepts covered in a given unit. We generally did not provide detailed instructional materials for the mathematics topics if they were covered in a typical high school curriculum, instead relying on the teachers to develop classroom materials based upon their prior experience and the needs of their students. We did, however, provide instructional materials for mathematics topics that might fall outside of typical Common Core aligned curriculums. For instance, we provided instructional materials for teaching the concept of expected value. We did not assume teachers had prior knowledge of spreadsheets, so we provided informational worksheets suitable for both teachers and students, introducing them to the relevant spreadsheet features.

For each unit, we provided teachers with the following materials:

1. **Outline:** Provides a scope and sequence, essential questions, and Common Core State Standards for the unit
2. **Teaching Companion**: Explains the material for each unit, with examples, suitable for teachers unfamiliar with finance
3. **Topic Quiz**: Questions that assess essential knowledge for each topic
4. **Mathematics Worksheet**: Worksheets that remediate and assess the mathematics component of each unit
5. **Spreadsheet Worksheets**: Explains how to use the relevant spreadsheet tools for each unit
6. **Additional Instructional Materials:** Additional practice questions for difficult topics, games, and activities for the classroom.
7. **Project:** An end of unit take-home project that requires analysis of a realistic financial scenario

We also provided additional support, visiting each class approximately once a month and maintaining email contact to answer any questions in the interim. Two of the classes (from Pilot School #1and Pilot School #2) visited us at the Andrew Davidson & Co. office, our founder's financial analytics firm. Students were given the opportunity to talk to staff about their work in the financial sector, as well as give presentations of their own. Many of the students had not previously seen this type of work environment. We hope to find similar ways to engage students as the program expands. We would also like to establish an after school session with parents to compliment the course.

4. Findings

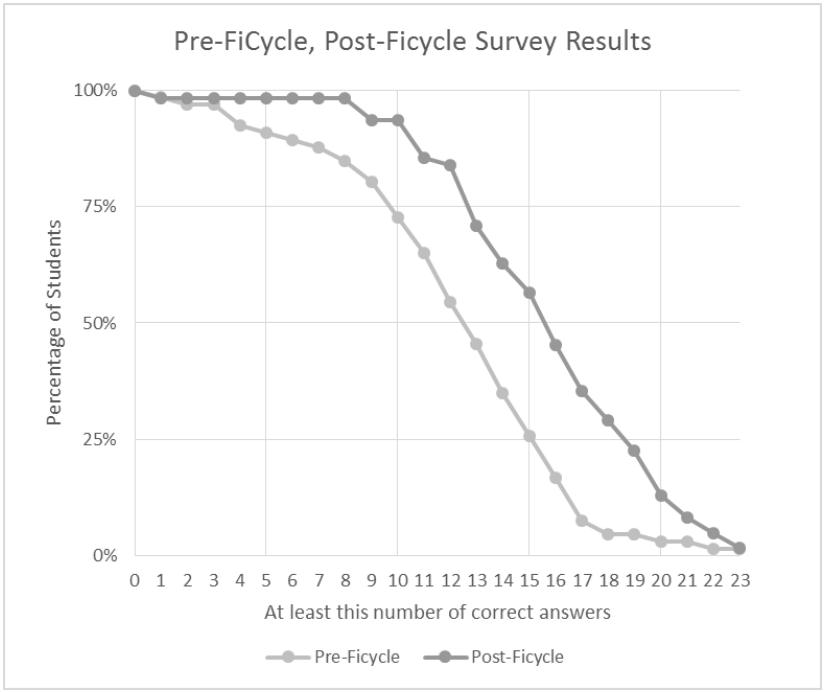
To assess the pilot, we created a survey that students completed before and after taking the course. The survey was available online or in printed format. The survey contained fifteen multiple choice questions that tested financial literacy, and nine questions on mathematics and financial mathematics. It also asked students to rate their confidence in addressing six financial issues, and asked them to reflect and comment on the course. Approximately 80 students responded to both the pre- and post-survey. A copy of the survey and end of year results are attached to the end of this paper (see Appendix).

Across the schools, and across the three types of questions, the results were reasonably consistent, displaying improvement from the beginning to the end of the course across the board. At the start of the course, the average (mean) percentage of questions the students answered correctly was 38% of the questions. At the end of the course this had increased by 26% from 38% to 48%. For self-assessments of confidence, the highest degree of confidence was the

'correct' answer. On the initial survey, the median number of correct answers for an individual student for self-assessments of confidence was 12.5; in the end of term survey, it was 15.5. This was an improvement of 24%.

In terms of the percentage of students achieving a level of proficiency, the results were more dramatic. Figure 1 shows the percentage of students getting at least the number of correct answers shown on the x-axis. While just over 50% of the students had 12 correct answers on the initial survey, over 80% of the students had 12 correct answers on the ending survey. Similarly, the percentage of students who had half of the 30 questions correct more than doubled from 25% before exposure to the FiCycle curriculum to 56% after exposure to the FiCycle curriculum.

Figure 1. Survey Results



Included in our survey were the 'big 5' questions in financial literacy. These five questions come from the US Financial Capability Study, and are often taken as the standard

measure of financial literacy (Finra, 2015). Before exposure to the FiCycle curriculum, students got an average of 1.5 questions correct. After exposure to the FiCycle curriculum, students got an average of 1.9 questions correct – an improvement of 27%. We also asked students to rate their confidence in performing financial tasks, and engaging in financial discussions. The number of students expressing high confidence increased from 36% to 46%. While these results are preliminary, in that there were a relatively small number of students represented in the data, they are still promising.

The survey also allowed space for students to comment on the course, and these comments were overwhelmingly positive: 90% of students said they would recommend this course to a friend. Many commented that it made them appreciate the importance of mathematics, and that taking the course would help them in the future. About two-thirds of the students reported specific financial actions that they had taken as a result of the course. These included opening bank accounts, saving money, and having financial discussions with family members.

We also provided the teachers (n=3) with an end of course survey which was more exploratory in nature. One teacher wrote that the best part about teaching the FiCycle curriculum was "instances of kids getting so engaged in the narrative and content." Another teacher wrote that "the best part of FiCycle was the copious amount of relatable material for students to be interested in." The third teacher wrote that the best part was "the students told me they learned a lot and I also learned a lot too."

Finally, perhaps the most important marker of the success of our pilot project was that all three pilot schools decided to use the course again the following year – and two of them more than doubled their enrollment.

5. Summary, Conclusions, and Next Steps

Overall, the results of the pilot were extremely promising. They backed up the findings of the research we reviewed and our view on the value of combining mathematics and finance. Our results also suggest that that the mathematics teachers are very capable of teaching a course in financial math, even if they have no prior knowledge of financial theory. Furthermore, they imply that high school students are interested in taking such a course and are able to understand and engage with both the financial and mathematical content.

Encouraged by these results, we pursued an expanded rollout of the FiCycle course for the following school year (2017-2018). For this year, there are 8 schools, 12 teachers, and several hundred students enrolled in the course. We have edited our materials based on our findings, enhanced our professional development to accommodate this increase in the number of teachers, and we will be tracking their progress both through surveys, email contact and classroom visits.

Alongside the expansion of our course, these results also suggest it would be worthwhile for other researchers to study the effects of courses that combine mathematics and personal finance. As a promising, but understudied approach to financial education, it deserves further investigation by independent researchers. By researching and perfecting best practices in financial education, we are hopeful that financial outcomes in the U.S. can be improved.

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