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The Connection between Financial Literacy and Numeracy: A Case Study from India

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The Connection between Financial Literacy and Numeracy: A Case Study from India

Abstract

Making financial decisions involves mathematical calculations, both simple and complex. It is a well-documented fact that financial literacy levels among young people all over the world are quite low and that these low levels contribute to various undesirable outcomes with respect to personal financial well-being and the economy as a whole. This study explores the relationship between financial literacy and numeracy by measuring and modeling the relationship between financial literacy and numeracy levels among high school students (N = 586) in India. The results show a strong relationship between numeracy and financial literacy skills. Low numeracy is associated with a 4.8% reduction in financial literacy, while a high level of numeracy is associated with a 5.6% increase. This relationship is robust and held even when controlling for factors including gender, grade, education stream, level of financial education, language of instruction, parental involvement, parental education, family income, and future education plans. Because there is a strong relationship between numeracy and financial literacy, educational policy should consider increasing numeracy skills as one of the means of improving financial literacy. In particular numeracy as it relates to financial literacy (e.g., interest calculations, chart/data comparisons, and interpretations) should be promoted as part of the curriculum.

Keywords

financial literacy, numeracy and financial literacy, financial education, India, developing countries, quantitative literacy, quantitative literacy

Cover Page Footnote

Dr. J.D Jayaraman is an Associate Professor of Finance and Data Science at the New Jersey City University School of Business. He has over fifteen years of experience on Wall Street and over eight years of experience teaching finance. His primary research interests are in improving financial literacy among young people. More specifically, his work examines the use of innovative teaching methods and cutting edge technology to engage students and improve learning of personal finance. Dr. Saigeetha Jambunathan is a professor of Early Childhood Education at New Jersey City University with over twenty years of experience. Her research interest is in the areas of developmentally appropriate practices in early childhood classrooms, teacher beliefs about the use of developmentally appropriate practices, cross-cultural comparisons of parenting attitudes, and children's perception of self-competence. More recently, Dr. Jambunathan has also started research on financial literacy among early childhood educators and factors that prevent them from teaching financial literacy concepts in their classrooms. Dr. Kenneth Counselman is an Associate Professor of Early Childhood Education at New Jersey City University with over 40 years of experience as an educator. His research interests are in the area of developmentally appropriate practices, multi-modal methods of teaching and learning, and use of block play to promote math skills in early childhood classrooms. He has served on the governing board for many accreditation organizations.

Introduction

Making financial decisions requires performing a variety of calculations, some fairly complex. The President's Advisory Committee on Financial Literacy (PACFL) defines personal financial literacy as "the ability to use knowledge and skills to manage financial resources effectively for a lifetime of financial well-being" (PACFL 2008). One of the key skills required to manage one's financial resources effectively is the ability to do basic mathematical calculations, such as percentages, and more sophisticated calculations, such as computing compound interest.

Many studies around the world have found low levels of financial literacy among people of all ages. The 2015 Program for International Student Assessment (PISA) survey of 15 year olds found financial literacy to be low in many of the 34 Organization for Economic Cooperation and Development (OECD) countries, with financial literacy in the United States below the OECD average (OECD 2017). The PISA study found that 22% of all students surveyed do not have basic financial skills and only 12% of students are able to handle fairly difficult financial tasks (OECD 2017). Borodich et al. (2010) compared the financial literacy of high school students in Japan, the United States, and Belarus and found that the Japanese students fared much better than their peers in the other two countries. Cameron et al. (2013) found similar results when they compared the personal financial literacy of high school students in New Zealand, the United States, and Japan: though all three countries fared poorly, Japan fared better than the others. Thus, low levels of financial literacy is a worldwide problem.

The gender gap in financial literacy among high school students is another area of concern. Many studies have found significant gender differences in financial literacy of high school students with males outperforming females (e.g., Varcoe et al. 2005; Danes and Haberman 2007; Hanna et al. 2010; Butters and Asarta 2011; Butters et al. 2012). However, Walstad et al. (2010) find no significant gender differences in financial literacy among high school students after participating in an intervention program, which is an encouraging sign that the gender gap can be closed by financial education.

Lack of financial literacy has been linked to making bad financial decisions that impacts one's future (Cole et al. 2011). Low levels of financial literacy prevent people from planning for retirement (Lusardi and Mitchell 2007b), increase the cost of borrowing (Stango and Zinman 2009), lead people to accumulate less wealth (Lusardi and Mitchell 2007a), and lower stock market participation (Van Rooij et al. 2011). Similarly, de Bassa Scheresberg (2013) find that young Americans with higher confidence in their financial literacy and math knowledge did not borrow at high interest rates, planned for retirement, and saved for emergencies. Thus, the

economic impact of financial illiteracy is significant. A simulation study of a life cycle model of financial literacy finds that lack of financial literacy can explain close to half of the wealth inequality that exists in the United States (Lusardi et al. 2017). Despite the compelling evidence, many countries have not taken any substantial steps to educate and empower students with appropriate financial education. According to the 2015 report by the Center for Financial Literacy at Champlain College on how high schools in the United States are providing financial literacy education, of the 50 states only 10% received a letter grade of A, 39% received a B, 22% received a C, 6% received a D and 24% received an F.[1] This report also details reasons for the low grades: poor teacher training, lack of appropriate curriculum and teaching strategies, lack of accountability in financial literacy education in terms of having appropriate assessments, lack of funding to develop curriculum and teacher training, and not looking at financial literacy holistically and integrating it across the curriculum. Thus, it is evident from the literature that financial education and financial literacy need to be improved drastically and hence the need for researchers to investigate effective means of improving financial literacy.

Numeracy is mathematical content embedded in real world contexts and is applied in particular situations (Shavelson 2008). Several studies have attempted to measure numeracy and its relationship to financial literacy. The numeracy that we are concerned with and which is measured in the financial literacy literature, focuses on simple mathematical skills that are needed for everyday financial calculations. Lusardi and Mitchell (2011) designed questions to measure numeracy and financial literacy that were included in the 2004 Health and Retirement Study (HRS) in the United States. Based on the 2004 HRS survey data the authors found low levels of numeracy, in addition to low levels of financial literacy, among older Americans (age 50 and older). Gerardi et al. (2010) find that these numeracy gaps are correlated with poor financial decision making. When asked to answer five numeracy questions, only 13% of subprime-mortgage borrowers answered all correctly.

These problems are not limited to the United States. The English Longitudinal Study on Aging reports that only 11% of the respondents in the United Kingdom correctly answered all five numeracy questions (Banks and Oldfield 2007). (These questions were also used by Gerardi et al. [2010] cited above.) Numeracy has been found to be low in many countries in Europe, with Germany, the Netherlands, and Sweden being among the highest and Italy and Spain being among the lowest (Christelis et al. 2010). In all of these studies, the questions requiring numerical

[1] http://www.champlain.edu/centers-of-excellence/center-for-financial-literacy/report-making-the-grade/the-case-for-high-school-financial-literacy

calculations for performing simple interest computations came out to be the ones that were answered incorrectly by most.

Lack of financial literacy and numeracy with respect to financial calculations among high school students and college students is of particular concern. Young people are confronted with making many tough financial decisions and are inadequately prepared to make these decisions due to lack of financial literacy. Lack of financial literacy then can lead to undesirable outcomes such as excessive debt, loan default, and personal bankruptcy.

Because the level of financial literacy and numeracy is low in most countries, it is important to study whether there is a relationship between numeracy and financial literacy. If there is a clear relationship between the two, then policies could be put in place to focus on increasing numeracy skills as a means of improving financial literacy. Moreover, almost all of the studies measuring numeracy and financial literacy have been conducted in developed countries in North America and Europe. Cole et al. (2011), a notable exception, report low levels of both financial literacy and basic mathematics competency in India and Indonesia. This lack of evidence makes the study of numeracy and its relationship to financial literacy even more important in developing countries. To the best of the author's knowledge there are no studies measuring numeracy in a developing country as it relates to financial literacy and exploring the relationship between them. This study investigates the relationship between financial literacy and numeracy among high school students in India. Thus, this study is among the first to shed light on the relationship between numeracy and financial literacy in a Southeast Asian country, India, which has very different cultural beliefs with respect to saving and retirement as compared to western countries.

The Indian Education System

Because our research sample is from India, a brief description of the Indian education system is provided for context. The secondary school system in India consists of ninth and tenth grades (students 14 to 15 years old), typically referred to as secondary school, and eleventh and twelfth grades (students 16 to 17 years old), typically referred to as higher secondary school. Higher secondary school attendance is required of students if they are college bound. Schools are run either by the government (central/state/local) or by private institutions. There are various education curriculums that schools follow; the most prominent of these are the Central Board of Secondary Education (CBSE) curriculum, Council of Indian School Certificate Examinations (CISCE) curriculum, and State Government Board curriculum. The medium of instruction in all schools is either English or the local language, which varies from state to state. The medium of instruction in

government-run schools tends to be the local language while the medium of instruction in private schools is largely English.

The 9th and 10th grade curriculum includes instruction in the following content areas: three Languages (English, the local language in the state, and another language), social studies, science and technology, math, vocational education, art, and physical education. The mathematics content taught in these two grades consists of arithmetic concepts, number systems, algebra, geometry, trigonometry, statistics, measurements, graphs, and coordinate geometry. At the higher secondary school, after 10th grade, students choose between either the commerce stream or the science stream. Students in the commerce stream predominantly study subjects such as economics, accounting, and mathematics, while students in the science stream study subjects such as physics, chemistry, biology, and mathematics. The mathematics curriculum is the same for both streams. The mathematics curriculum at the higher secondary level includes the following concepts: sets and functions, algebra, coordinate geometry, calculus, mathematical reasoning, statistics and probability, relations and functions, vectors, and three-dimensional geometry. The position paper by the focus group on teaching mathematics, published by the National Council of Educational Research and Training (NCERT) in 2005, elaborates on many issues related to teaching math in the higher secondary grades in India, the most important of which are the benefits of breadth versus depth in mathematical concepts. The math curriculum in the 11th grade has more breadth while the one in the 12th grade has more depth, particularly in the calculus area. This arc in the curriculum is designed to prepare the students for the board exams and a variety of college entrance exams (NCERT 2005).

India has enacted several reforms in recent years to make education accessible to all children and to improve quality. However, teacher quality continues to be a challenge due to inadequate training, absenteeism, and other systemic difficulties (Beteille 2009). NCERT (2005) also raises concerns about the qualifications and dispositions of math teachers. In particular, they raise concerns about the ability of the math teachers to teach outside of traditional textbook instruction, helping students apply what they have learned in the class to the real world, and generalizing their math knowledge in other content areas, as well.

Methods

Survey Design

In the literature, financial literacy is measured by either a performance test or a self-assessment or both (Huston 2010; Hung et al. 2009). Performance tests measure knowledge in various financial literacy domains such as savings, investments and debt, while self-report tests ask participants to rate themselves on their perceived knowledge in financial literacy domains.

Numeracy as it relates to financial literacy has been measured in the literature using survey questions. Lusardi and Mitchell (2007a) used three questions from the 2004 U.S. Health and Retirement Study (HRS) that test basic numeracy in order to assess the impact of numeracy on financial decision-making by early baby boomers. The baby boomers surveyed were in the age range 51-56 at the time of the survey and the financial decision-making surveyed was in the context of retirement planning. The English Longitudinal Study on Aging (Banks and Oldfield 2007) used the same three questions as Lusardi and Mitchell (2007a) and an additional two questions to measure numeracy.

The survey used in this study measures numeracy with two questions from Lusardi and Mitchell (2007a) and one question from Lusardi and Mitchell (2017).[2] The complete survey is shown in Table 1 and the questions are labelled for easy reference in the text. The first numeracy question (N1) assesses knowledge of percentage calculation, the second question (N2) tests knowledge of division, and the third question (N3) assesses knowledge of numerical calculations in the context of interest computation. (In these and subsequent items, questions were altered to reflect the Indian context by changing currency units and names.) The three questions used in our survey were not intended to measure the overall numerical capabilities of the children. Instead, they were meant to measure the key aspects of numeracy (such as percentages) that are needed for financial calculations. This three question survey, despite being brief, has been used as a measure of numeracy in prior literature (e.g., Lusardi and Mitchell 2007a).

Financial literacy in four domains—compound interest/inflation, investing, borrowing, and insurance—was measured using 17 questions. The compound interest/inflation section (C1 - C4) uses the four basic financial literacy questions in Lusardi and Mitchell (2017). The first question (C1) in the compound interest section is similar to the third question (N3) in the numeracy section but with added wording to indicate that the interest earned is left in the account, thus suggesting that this interest amount will earn additional interest (interest on interest). The investing section (I1 - I8) is comprised of the eight sophisticated financial literacy questions used in Lusardi and Mitchell (2017). The borrowing section (B1 - B3) uses one question from the Financial Industry Regulatory Authority 2009 National Financial capability Study and two questions from the Jump$tart survey.[3] The insurance section (S1 - S2) uses one question from Chen and Volpe (1998) and one question from the Jump$tart survey. The survey does not attempt to measure all possible aspects of financial literacy because that would be overly long and

[2] Permission has been received from all the authors to use their financial literacy and numeracy survey questions in our research and to print them in any publications.

[3] http://www.usfinancialcapability.org/ and http://jumpstart.org/survey.html

Table 1
Financial Literacy and Numeracy Survey Questions

Label	Question
Numeracy	
N1	If the chance of getting a disease is 10 percent, how many people out of 1,000 would be expected to get the disease? a. 100 b. 90 c. 10
N2	If 5 people all have the winning number in the lottery and the prize is 20 lakh rupees, how much will each of them get? a. ₹2,00,000 b. ₹4,00,000 c. ₹1,00,000
N3	Suppose you had ₹100 in a savings account and the interest rate was 2 percent per year. After 5 years, how much do you think you would have in the account if you left the money to grow: a. more than ₹102 b. exactly ₹102 c. less than ₹102
Compound Interest and Inflation	
C1	Suppose you had ₹1000 in a savings account and the interest rate is 20 percent per year and you never withdraw money or interest payments. After 5 years, how much would you have in the account in total: a. more than ₹2000 b. exactly ₹2000 c. less than ₹2000
C2	Imagine that the interest rate on your savings account was 1 percent per year and inflation was 2 percent per year. After 1 year, would you be able to buy: a. more than today with the money in this account b. exactly the same as today with the money in this account c. less than today with the money in this account
C3	Assume a friend inherits ₹10,000 today and his brother inherits ₹10,000 three years from now. Who is richer because of the inheritance? a. My friend b. His brother c. They are equally rich
C4	Suppose that in year 2020 your income has doubled, and the prices of all goods have doubled too. In 2020 how much will you be able to buy with your income? a. more than today b. The same c. Less than today
Investing	
I1	Which of the following statements describes the main function of the stock market? a. The stock market helps to predict stock earnings b. The stock market results in the increase in the price of the stocks c. The stock market brings people who want to buy stocks together with those who want to sell stocks d. None of the above
I2	Do you think that the following statement is true or false? "Buying a single company stock usually provides a safer return than a stock mutual fund." a. True b. False
I3	Which of the following statements is correct? a. Once one invests in a mutual fund, one cannot withdraw the money in the first year b. Mutual funds can invest in several assets, for example, can invest in both stocks and bonds c. Mutual funds pay a guaranteed rate of return based on their past performance d. None of the above
I4	If interest rates rise, what will typically happen to bond prices? a. They will rise b. They will fall c. They will stay the same d. There is no relationship
I5	True or False? "Stocks are normally riskier than bonds" a. True b. False
I6	Considering a long period (e.g. 10 or 20 years) which asset normally gives the highest return? a. Saving accounts b. Bonds c. Stocks
I7	Normally which asset displays the highest fluctuations over time? a. Savings accounts b. Bonds c. Stocks
I8	When an investor spreads his money among different assets, does the risk of losing money: a. Increase b. Decrease c. Stay the same

Table 1 (cont.)
Financial Literacy and Numeracy Survey Questions

Label	Question
Borrowing	
B1	A 15-year housing loan typically requires higher monthly payments than a 30-year housing loan but the total interest over the life of the loan will be less. a. True b. False
B2	Vijay and Mohan are young men with good credit histories. Vijay has borrowed ₹60,000 to take a foreign vacation while Mohan has borrowed ₹60,000 to buy a car. Who is likely to pay the lower finance charge? a. Mohan will pay less because the car is collateral for the loan b. They will both pay the same because the interest rate is set by law c. Vijay will pay less because people who travel overseas have less risk of not repaying the loan d. They will both pay the same because they have similar financial backgrounds
B3	Which of the following credit card users will pay the maximum amount in finance/interest charges per year? a. Raman, who always pays off his credit card bill in full each month b. Ajith, who only pays the minimum amount each month c. Lakshmi, who pays at least the minimum amount each month and more when she can afford it d. Kavitha, who usually pays her bill in full but occasionally pays the minimum amount
Insurance	
S1	The main reason for purchasing insurance is to a. Protect you from a loss that recently occurred b. Provide you with good investment returns c. Protect you from sustaining a catastrophic loss d. Protect you from small incidental losses
S2	If each of the following persons have the same amount of take home pay, who would need the greatest amount of life insurance? a. An elderly man with a wife who is also retired b. A young married man without children c. A young single woman with two young children d. A young single woman without children
Demographics	
D1	Gender: a. Male b. Female
D2	Grade: a. 10^{th} b. 11^{th} c. 12^{th}
D3	Education Stream: a. Commerce b. Science
D4	What is the highest level of schooling your father or mother has completed a. No schooling b. Neither completed high school c. Completed high school d. Some college e. College graduate or more than college
D5	What are your educational plans after high school? a. No further education is planned b. Attend a 2 year college or Junior college c. Attend a 4 year college or university d. Vocational training
D6	Approximately on an average what do you score on your mathematics exams a. Under 30% b. 30% - 50% c. 50% - 75% d. 75% - 90% e. Above 90%
D7	Which best describes your family's annual income a. Less than ₹1,00,000 b. Between ₹1,00,000 and ₹3,00,000 c. Between ₹3,00,000 and ₹5,00,000 d. Above ₹5,00,000
D8	On a scale of 1 to 7, 1 being very low and 5 being very high, how would you assess your understanding of economics and finance? a. 1 b. 2 c. 3 d. 4 e. 5

Table 1 (cont.)
Financial Literacy and Numeracy Survey Questions

Label	Question
D9	How much of your school education has been devoted to economics and/or finance? a. None b. Very little c. Some d. A lot
D10	What financial matters do your parents discuss with you? a. Saving b. Borrowing c. Investing d. My parents discuss all or some of the above with me e. My parents do not discuss any financial matters with me

logistically difficult to administer. Consequently, we picked the four important domains of financial literacy that have been consistently measured in extant literature. The questions used in our survey to assess financial literacy and numeracy have been widely used in the literature and have also been used in large-scale government studies.

The "do not know/refuse to answer" response option was removed from the original questions in line with other studies such as the Jump$tart survey (Mandell 2008) and that of Erner et al. (2016) which use the same basic (C1 – C3) and sophisticated (I1 – I8) financial literacy questions as in our survey. While there are pros and cons to including a "do not know" option in surveys, in recent years the scientific consensus has shifted towards omitting the "do not know" option. Krosnick (1991 argues that answering survey questions requires cognitive work and that the "do not know" option gives respondents a way to avoid this cognitive work. Krosnick et al. (2002) find that including the "do not know" option did not improve data quality and that respondents would have provided substantive answers if the option was not included.

Our survey also asks for demographic information and self-assessment information as specified in questions D1 – D10 in Table 1.

Sample

We constructed a purposive sample. The survey was conducted in two southern Indian cities, Chennai and Madurai, in the state of Tamilnadu. Chennai is the capital of Tamilnadu, and Madurai is the second largest city in Tamilnadu. The survey was given to 620 high school students in grades 10, 11 and 12 in three schools. All of the students in the three grades participated in the survey. The three schools were selected based upon the authors' relationship with the school administration and their willingness to participate in the study. Two of the schools were single-gender (female) schools located in Chennai and the other was a coeducational school located in Madurai. The survey was translated in the local language, Tamil, for two of the schools where the medium of instruction was Tamil. The third school's

medium of instruction was English. These two Tamil-medium schools were the all-girls schools. The girls in these schools were from a lower socioeconomic status, while the students from the English-medium school were from middle- and upper-socio-economic status. We excluded 34 participants due to incomplete data resulting in a sample of $N = 586$. Our sample consisted of 457 females and 129 males. Among these, 331 students were pursuing the commerce stream and 255 students were pursuing the science stream. At the time of the survey, 162 students were in the 10^{th} grade, 261 in grade 11, and 163 in grade 12. The students ranged in age from 14 to 18 years old.

The surveys were administered to the students by their teachers in the school, during school hours. The use of calculators was not allowed. The researchers were present in the school when the surveys were being administered to answer any questions that might arise. The teachers were instructed not to help the children with answering the questions. We set no time limit for answering the survey, but all students completed the survey within 20 minutes. No incentives were provided for completing the survey.

Analysis

Percentage correct scores (PCS), defined as the number of correct answers divided by the total number of questions, were examined in our analysis. This methodology is consistent with many other studies on financial literacy (e.g., Mitchell 2009 and Lusardi and Erner et al. 2016). There are four subscales in the financial literacy survey: basic financial literacy (compound interest/inflation), sophisticated financial literacy (investing), borrowing, and insurance. Mean PCS for each of the financial literacy subscales were computed to provide a measure of basic financial literacy, sophisticated financial literacy, and knowledge of both borrowing and insurance.

The reliability (Cronbach's Alpha) of the financial literacy section of the survey was 0.73 and the reliability of the numeracy section of the survey was 0.69. The reliability of our survey questions were further examined by looking at the pairwise correlation between the items. The correlations ranged from 0.27 to 0.79 for the financial literacy section of the survey and 0.39 to 0.72 for the numeracy section of the survey. The questions used in our survey, especially the basic financial literacy questions (C1 – C3), the sophisticated financial literacy questions (I1 – I8), and the numeracy questions (N1 – N3), have been used in numerous other surveys over the past several years with both high school students and adults in various countries, including Asian countries (e.g., the 2015 PISA survey of 15-year-olds in 15 countries), and have established content validity.

The dependent variable, financial literacy, is a ratio scale variable with a wide range (11.76% to 76.47%) and standard deviation of 13%. No values were near the floor of zero. Hence, following many others in the literature, we treat this measure

as a continuous variable (Chen and Volpe 1998; Van Rooij et al. 2011; Erner et al. 2016; Lusardi and Mitchell 2017).

Following the approach of Erner et al. (2016), to assess the relationship between numeracy and financial literacy after controlling for confounding variables, we estimate a three-level linear mixed model with random intercepts for school and grade:

$$\begin{aligned} Literacy \;=\; & \beta_1 Numeracy + \beta_2 Female + \beta_3 Science\ Stream + \beta_4 Medium \\ & + \beta_5 Parent\ Education + \beta_6 EPlans + \beta_7 Income \\ & + \beta_8 Financial\ Education + \beta_9 Parent\ Involvement + u_{School} \\ & + u_{Grade} + \varepsilon \end{aligned}$$

where u_{School} and u_{Grade} capture the effects of school and grade, respectively.

This model accounts for the lack of independence within clusters by building in random effects associated with each cluster. This type of model is typically used with educational data where students are nested within grades, which are in turn nested within schools.

The primary independent variable of interest, Numeracy, is a PCS measure based on only three questions, resulting in four possible values. As a result, we treat it as a discrete variable. Because very few (22) in our sample answered all the numeracy questions incorrectly, we opted to go with three levels of numeracy: low (0 or 1 question correct), medium (2 questions correct), and high (3 questions correct).

"Parent education" represents a set of indicator variables defined as the highest level of education attained by the parents (father or mother) as reported in Question D4. The variable "education plans" similarly uses indicator variables to represent answers to question D5, with two-year and four-year college attendance combined in a single category. All other control variables represent indicator variables reflecting answers to questions D1, D3, D7, D9, and D10.

Results and Discussion

Table 2 shows the PCS and guessing probabilities for the numeracy questions. The three numeracy questions are labelled "percentage," "division," and "interest calculation" to indicate what type of calculation is being expected by the question. The mean PCS for numeracy across all students was 81.0% and was significantly different from the guessing probability ($p < 0.01$). The PCS for each of the three questions were also significantly different from the guessing probability ($p < 0.01$). The fact that the PCS was statistically different from the guessing probability and the large difference between the guessing probability and the actual score (33% vs

Table 2
Percentage Correct Score for Numeracy

	Guessing Probability (%)	Percentage Correct Score (%)
Numeracy	33.3	81***
N1: Percentage	33.3	81***
N2: Division	33.3	87***
N3: Interest Calculation	33.3	75***

Note: Asterisks at the question level indicate the *p*-value associated with a two-tailed *t* test of the hypothesis that the mean percent correct equals the guessing probability. Asterisks at the aggregate level indicate the *p*-value associated with a two-tailed *t* test of the hypothesis that the aggregate mean percent correct equals the guessing probability. ***$p < 0.01$

Table 3
Percentage Correct Score for Financial Literacy

	Guessing Probability (%)	Percentage Correct Score (%)
Overall Financial Literacy	32.9	44***
Compound Interest / Inflation (Basic Financial Literacy)	33.3	45***
Investing (Sophisticated Financial Literacy)	34.4	44***
Borrowing	33.3	40***
Insurance	25	50***

Note: Asterisks at the question level indicate the *p*-value associated with a two-tailed *t* test of the hypothesis that the mean percent correct equals the guessing probability. Asterisks at the aggregate level indicate the *p*-value associated with a two-tailed *t* test of the hypothesis that the aggregate mean percent correct equals the guessing probability. ***$p < 0.01$

81.0%) implies that the majority of the students did not guess the answers to the numeracy questions. The 74.6% PCS on the interest calculation question (N3) was the lowest, indicating that it was the most difficult of the three questions and involved a more sophisticated calculation. This result is consistent with other literature that finds interest calculations to be the most difficult numeracy question (Banks and Oldfield 2007; Lusardi and Mitchell 2011). The 81.0% mean PCS is fairly high, but does not come as a surprise as high school students in India are expected to have mastery over basic mathematics skills. Our finding of high levels of numeracy among the students is similar to other findings of fairly high levels of numeracy among young people in the U.S. (Lusardi et al. 2010).

Table 3 presents the PCS and guessing probabilities for financial literacy and its subscales. All the PCS scores were significantly different from the guessing probability ($p < 0.01$), and the difference between the guessing probability and the actual score (32.9% vs 44.2%) was fairly large, implying that the majority of the students did not just guess the answer to the financial literacy questions. The 44.2% overall financial literacy was lower than that found using the same sophisticated financial literacy questions in Germany and the United States. In those studies, Erner et al. (2016) and Lusardi and Mitchell (2017) report mean scores of roughly 48%. The PCS for the subscales were roughly around the overall financial literacy levels, with knowledge of borrowing being the lowest (40.1%) and knowledge of insurance being the highest (49.7%).

Table 4 reports mean numeracy and financial literacy scores by demographic subgroups. There was a significant ($p < 0.01$) difference in numeracy by self-

Table 4
Numeracy and financial literacy by various groups

	Numeracy PCS (%)	Financial Literacy PCS (%)
Math Score		
Under 30	39%	39%
30 to 50	68%	42%
50 to 75	80%	44%
75 to 90	85%	46%
Above90	82%	43%
F Statistic	14.00***	1.83
Gender		
Male	75%	40%
Female	83%	45%
F statistic	7.11***	15.02***
Education Stream		
Science	73%	38%
Commerce	88%	49%
F statistic	50.27***	149.10***
Grade		
10	73%	39%
11	84%	45%
12	85%	47%
F Statistic	9.60***	20.50***
Medium of Education		
English	76%	40%
Tamil	85%	47%
F statistic	16.90***	47.45***
Parental Education		
No School	72%	44%
Did not complete high school	85%	47%
Completed high school	85%	44%
Some college	76%	42%
College graduate	78%	40%
F statistic	4.70***	5.283***
Future Educational Plans		
No further education	70%	41%
Attend college	83%	45%
Vocation training	60%	39%
F statistic	10.80***	3.13**
Income		
Poor	88%	47%
Middle	75%	40%
Upper Middle	73%	42%
Rich	70%	43%
F Statistic	17.00***	11.42***

Note: Asterisks level indicate the *p*-value associated with an *F* test of the hypothesis that the mean percent correct is the same for all subgroups if a given demographic variable. *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

reported math scores. Students who self-reported low math scores did score poorly on numeracy, but we did not find any significant difference in the financial literacy scores by self-reported math scores. Though the results were not statistically significant, those who reported low math scores did have lower financial literacy

(39%) than the ones who reported high math scores (46%). The statistically insignificant results may mean that students' self-assessments of their own math abilities are not a good indicator of their financial literacy. Further research needs to be done in order to confirm this hypothesis.

Numeracy and financial literacy do seem to differ by socioeconomic status, with poor students actually showing much better numeracy skills (88%) than their wealthier counterparts (70%). One potential explanation for this result could be that poorer children are more involved in the day-to-day running of the family and in many cases contribute to the income of the family by doing small jobs. This experience could potentially enhance their numeracy skills. There is some support to this argument provided by a study of mathematical abilities of child street vendors in Brazil (Saxe 1988) and a study of mathematical skills of children working in informal markets in India (Banerjee et al. 2017). This hypothesis would be an interesting topic for future research. We also find that students who planned to attend college had a higher level of numeracy and financial literacy than those who did not.

We find significant ($p < 0.01$) gender differences in numeracy with female students scoring 8 percentage points higher than the male students. A similar gender difference was also seen in financial literacy levels, with females outperforming males. White et al. (2016) report gender differences in mathematical achievement among 8- to 11-year-old children in India with males outperforming females, which is contrary to our finding, though our study involved a different age group (14 to 18 years old) and measured numeracy as opposed to mathematical achievement. We also analyze whether there was a similar gender difference among the students in the one coeducational school in our sample and find no significant gender difference. The students in the coeducational school were from a middle/upper middle class background. This fact leads us to hypothesize that the gender differences that we find may be driven by socioeconomic status.

We also find a fairly large and significant difference in numeracy between students in the science vs. commerce streams, with the latter exhibiting a 15 percentage-point higher level. Anecdotal evidence suggests that in India, students who are good at math tend to go the science route. If we make the reasonable assumption that students who have good math skills will also have good numeracy skills, this finding surprises us. We suspect that this finding may be intertwined with the finding of gender differences and socioeconomic differences because the majority of commerce students in our sample were girls from a lower socioeconomic background. So, we again look at the coeducational school, which is more homogeneous, and see a similar difference in numeracy across the two curricular streams. We also see a difference in numeracy across socioeconomic status, but not across gender. This leads us to suggest that gender may not have as big a mediating effect on curricular-stream differences as socioeconomic status.

Table 5
Relationship between Numeracy and Financial Literacy Conditional on Control Variables

	Linear Mixed Model		Ordered Logistic Regression	
	Financial Literacy		Financial Literacy	
Independent Variable	b	(SE)	b	(SE)
Numeracy (Low)	-0.048***	(0.028)	-1.05***	(0.45)
Numeracy (Medium)	-0.004	(0.026)	-0.46	(0.43)
Numeracy (High)	0.056**	(0.025)	0.12*	(0.42)
Female	0.005	(0.015)	0.135	(0.259)
Science Stream	-0.093***	(0.013)	-1.627***	(0.189)
Tamil Medium	0.019	(0.026)	0.408	(0.302)
Parent Education (Graduate)	-0.007	(0.015)	-0.175	(0.247)
Parent Education (Did Not Comp High School)	-0.002	(0.013)	0.029	(0.201)
Parent Education (No School)	-0.010	(0.017)	-0.101	(0.264)
Parent Education (Some College)	0.015	(0.018)	0.114	(0.279)
Income (Poor)	0.011	(0.015)	0.027	(0.231)
Income (Rich)	0.020	(0.018)	0.098	(0.319)
Income (Upper Middle)	0.018	(0.016)	0.116	(0.256)
Financial Education (None)	0.016	(0.023)	0.312	(0.346)
Financial Education (Some)	0.024**	(0.012)	0.588**	(0.191)
Financial Education (Very Little)	0.037**	(0.017)	0.865**	(0.273)
Parent Involvement (Borrowing)	-0.049	(0.031)	-0.746	(0.5)
Parent Involvement (Did Not Discuss)	0.002	(0.017)	-0.129	(0.264)
Parent Involvement (Investing)	-0.010	(0.024)	-0.326	(0.374)
Parent Involvement (Saving)	-0.002	(0.011)	-0.162	(0.168)
Education Plans (No Further Education)	-0.032	(0.026)	-0.634	(0.388)
Education Plans (Vocational Train)	-0.006	(0.022)	0.019	(0.352)

Note: Coefficients (b) and standard errors (SE) are from a three-level linear mixed model with school and grade as random intercepts and an ordered logistic regression model. *p < 0.10, **p < 0.05, ***p < 0.01

A similar education-stream difference is exhibited in financial literacy as well, but this can be explained by commerce students getting financial education by virtue of their economics curriculum.

Another surprising finding was the significant difference in numeracy by medium of education, with students taught in Tamil showing 9 percentage point higher levels. A similar difference is present in financial literacy. We believe that this result again reflects gender and socioeconomic differences, because a majority of the students taught in Tamil were girls from a lower socioeconomic status.

The discussion above repeatedly demonstrates the limitations of a bivariate analysis of the relationship between numeracy and financial literacy; with multiple potentially correlated factors explaining both numeracy and financial literacy, we need a multivariate approach to disentangle the various contributions. The first two columns of Table 5 present the results of fitting a three-level linear mixed model with random intercepts for school and grade. Even after controlling for other covariates, the results show a strong ($p < 0.01$) relationship between low numeracy and financial literacy skills. Low numeracy was associated with a 5.2 percentage-point reduction in financial literacy (relative to medium numeracy), even after controlling for a whole host of factors as described in the analysis section. High numeracy was associated with a 5.1 percentage-point increase. Thus, these findings

indicate that there is a fairly strong relationship between numeracy and financial literacy. Similar findings, though not directly comparable, are reported by Erner et al. (2016) with German high school students, where one math grade unit is associated with a 4% increase in financial literacy. The Erner et al. (2016) study did not attempt to measure numeracy as our study did, but instead used the math grade on the school report card (1 to 6 rating) as a proxy, but their study did measure financial literacy using the same basic and sophisticated financial literacy questions as our survey.

Though there are numerous precedents in the literature for treating the independent variable, financial literacy, as a continuous variable, we were curious if the results would differ substantially if we treated the independent variable as a discrete variable. Thus, we also fitted an ordered logistic regression model to the data with the independent discrete variable being financial literacy and the primary dependent variable being numeracy.

The third and fourth columns in Table 5 present the results of the ordered logistic regression model. The results are consistent with the linear mixed model, and show that low numeracy was significantly ($p < 0.01$) associated with decreased financial literacy and high numeracy was significantly ($p < 0.10$) associated with increased financial literacy. Thus, the results hold true whether financial literacy is treated as a continuous variable or a discrete variable.

Conclusion

This study is one of the first to explore the relationship between numeracy and financial literacy among high school students in a developing country. We find a strong statistically significant ($p < 0.01$) relationship between numeracy and financial literacy. This relationship is robust and held even when controlling for factors including gender, grade, education stream, language of instruction, parental involvement, future education plans, parental education, family income, and level of financial education.

A limitation of our study is that our sample consists of students from only three high schools in India. So, caution should be exercised in generalizing the results. Despite this limitation, the strong relationship between numeracy and financial literacy in our study suggests that educational policy makers should consider increasing numeracy skills and in particular promote numeracy as it relates to financial literacy (interest calculations, chart/data comparisons and interpretations, etc.) as part of the curriculum. An increase in numeracy skills was associated with a fairly large increase in financial literacy in our study, which suggests that increasing numeracy skills may effectively aid in increasing financial literacy. We caution that increasing numeracy should not be considered a substitute for

increasing financial literacy, rather, our results simply suggest that increasing numeracy may help in increasing financial literacy.

Our findings suggest the need for numeracy and financial literacy to be taught and learned in an integrated manner. These two areas naturally lend themselves to being integrated in teaching and learning. Because numeracy is mathematical content embedded in real world contexts, teachers should incorporate real world financial literacy contexts, such as interest rate calculations, into their mathematics curriculum. Such an integrated curriculum may help improve financial literacy and help our younger generation be wise decision-makers and consumers in the global arena.

In terms of directions for future research, studies need to be done to replicate our findings in other developing and developed countries. Research on effectively integrating financial literacy across the curriculum is in its infancy and needs further studying. A study of numeracy and financial literacy of street children would be fascinating. Further studies need to be performed to understand the mediating effects of variables such as socioeconomic status and gender on financial literacy and numeracy, so that appropriate interventions can be designed.

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