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ORIGINAL PAPER

# Early Causes of Financial Disquiet and the Gender Gap in Financial Literacy: Evidence from College Students in the Southeastern United States

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**Abstract**
Financial literacy, a cornerstone of family economic well-being, is surprisingly low in the United States. The literature has established that financial literacy is lower among women than among men. As sound financial decision-making among both male and female household heads is of paramount importance to well-being, we look to identify the underlying causes that may initiate and perpetuate this differential. We found that a gender-based gap in understanding develops by early college age, before individuals have had the opportunity to develop financial skills through experience or specialization in household roles. The literature indicates that women tend to underestimate their abilities relative to men, particularly in areas of math and financial decision-making. Math ability, financial confidence, and financial and math education have been found to enhance financial literacy, and so we focus on math self-efficacy as an early indicator of financial assurance and literacy. Using an ordered probit model and data from a sample of 529 college students across three institutions in the southeastern United States, we extend the current literature to find that for men, objective math ability drives financial literacy. For women, on the other hand, self-efficacy—and not objective ability—is predictive of financial literacy. Understanding the underlying causes of the gender-based financial literacy gap can inform the creation of better education, family, and cultural intervention methods by which to close this gap in financial literacy, decisions, and outcomes.

**Keywords** Financial literacy · Math · Gender gap

Despite advances in gender equality and growth in the number of woman-led families in the United States in recent decades, men are still considered more financially astute and confident (Webster and Ellis 1996). We hypothesize that these cultural perceptions begin early in the home and further relate to gender expectations vis-à-vis math ability. We explore the relationship between self-efficacy in math ability and financial literacy, especially as it relates to the gender-based gap in financial literacy. Although the connection between self-efficacy in math ability and financial literacy might not seem obvious, research has documented correlations among math performance, financial confidence, financial literacy, and financial decision-making (Xiao et al. 2014). Nonetheless, to the best of our knowledge, no study has examined the role of math self-efficacy on financial literacy. Given that individuals are exposed to math and related cultural views as they mature in the family setting, they tend to develop their math confidence earlier than their financial literacy confidence. Gender differences in perceived math ability may reduce investment in financial literacy and would suggest that gender differences in financial outcomes originate much earlier in life than expected. Our research results highlight the importance of parents and K-12 educators in developing assured math students and imply their influence on those students' future financial outcomes.

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Certain evidence has connected the provision of personal finance education to increased interest in developing financial literacy among young adults (Mimura et al. 2015). However, little has been done to address gender-based differences in the acquisition of financial literacy (Danes and Haberman 2007). Two plausible explanations for the gender-based financial literacy gap are knowledge of numerical applications and the confidence to participate in math-focused curricula, both of which have been found to differ on the basis of gender. Previous studies show evidence of a link between financial literacy and math ability (Agarwal and Mazumder 2013; Lusardi and Mitchell 2014; Xiao et al. 2014); others establish a gender-based gap in math ability (Al-Bahrani et al. 2018; Friedman 1989; Fryer and Levitt 2010; Niederle and Vesterlund 2010) and in math confidence (Cheema and Galluzzo 2013; Meeliseen and Luyten 2008; Sax 1994).

We contribute to the literature by exploring the role of self-efficacy in math on the accumulation of financial literacy. Self-efficacy has been defined as "a person's own judgment of capabilities to perform a certain activity in order to attain a certain outcome. Perception is implied in the definition of self-efficacy and does not change the meaning" (Zulkosky 2009, p. 95). This term can be attributed to Bandura's (1994) social-cognitive theory, and since then, attempts have been made to link it empirically to performance. Harrison et al. (1997) tested the self-efficacy performance model and addressed limitations of the body of empirical work that examined this hypothesized linkage and generalized those results. The current study falls within this category. Following Harrison et al. (1997), we measured self-efficacy using a five-point Likert scale, and asked participants about their confidence in their abilities; in this measurement respect, the current study is consistent with other self-efficacy (and/or perception) literature. To maintain terminological consistency, we use the terms "math self-efficacy" and "perceived math ability" interchangeably throughout this paper.

The participants in our study were college-age students; in this respect, our study diverged from many others in the literature that surveyed middle-age adults. By using a younger sample, we were able to capture early perceptions not yet shaped by personal experiences in making important financial decisions or in possibly taking up household specialization roles. The implication here is that the gender-based gap found in the current study is not experiential, but rather the product of educational, family, or cultural influences.

We contribute to the literature by drawing connections among the educational influence of math, math self-efficacy, and financial literacy. We tested for objective measures of math ability and surveyed participants regarding their perceived measures of math self-efficacy; this information served as our key data. Of course, math self-efficacy is neither an objective nor ordinal measure among individuals. By asking participants to self-rank their efficacy levels, personal biases were necessarily incorporated into the data; it is important to note, therefore, that the exact measure is *perceived* math self-efficacy. Problems would have occurred had we believed there to be systematic differences in confidence reports across groups within our sample. One could make arguments pertaining to race, gender, or other demographic characteristics, and so we controlled for these factors; we also measured and controlled for actual math ability by executing a SAT-based math test. Additionally, because students might simply and generally consider themselves good students, or be highly confident in general—or the inverse—we also asked participants about their verbal abilities and overall academic abilities. We found there to be no significant correlations with these ratings or results associated with these measures.

We measured the impact of perceived and actual math ability on financial literacy. We noted the work of Huston (2010) and hence distinguished "financial knowledge" and "financial literacy." Huston (2010) defined financial literacy as the combination of financial knowledge and the application of that knowledge, and so we could not infer that our participants who exhibited financial knowledge were also financially literate. Nonetheless, for the sake of consistency with a large proportion of the literature, we used the terms "financial literacy" throughout this paper; we understood that that in so doing, we may have overlooked a nuance uncovered by Huston (2010).

Our results suggest that both actual and perceived math ability are determinants of a student's financial literacy. Students with higher levels of math self-efficacy had higher rates of financial literacy than students who reported lower perceived math ability. Students who were above average in math ability also scored more highly on assessments of financial literacy. These findings suggest that both perceived and actual math ability impact students' knowledge of personal finance concepts.

Our primary contribution is the finding that the impact of confidence on financial literacy is sensitive to gender. A man's financial literacy outcomes were less likely to be impacted by his perception of his math ability; on the other hand, a woman's actual math ability did not predict her financial literacy score, but her perceived math ability did affect her financial literacy.

We hypothesized that this linkage is established through perceived investment cost: math-confident individuals' perceived investment costs for financial knowledge acquisition were lower than those of their less-confident counterparts. Thus, it is ultimately the investment made towards knowledge acquisition—driven by the perceived cost viewed through the lens of one's own self-efficacy regarding math ability—that is key, and that acquisition directly impacts

financial literacy. Because most financial experience is delayed until adulthood, individuals must rely on previous related experience to form their self-efficacy beliefs. Math skills closely relate through a conceptual framework and required computation, and thus provide a reference point for individuals as they form their self-efficacy beliefs.

We also found a relationship between math self-efficacy and the gender-based gap in financial literacy. We did not extend this research to test for differences in financial behavior, but did expect perceptions of math ability to lead to differences in future financial outcomes. The gender-based gap in financial literacy and in math confidence has been well documented (Ganley and Lubienski 2016; Lusardi and Mitchell 2014). We found the origins of the gender-based financial literacy gap to be observed early in life and relate to confidence in math ability. While it is beyond the scope of our paper to discuss methods of increasing math self-efficacy and thus achieve these favorable outcomes, we found evidence of the underlying causes of these problems. Early family and educator interventions by which to close the gender-based gap in perceived math ability may attenuate the gender-based financial literacy gap and, consequently, gender-based wealth gaps.

## Literature Review

There is a direct connection between financial literacy and the financial climate of one's family of origin. Jorgensen et al. (2019) found that millennial students who were taught financial knowledge early in the home express gratitude for financial lessons from parents and grandparents; meanwhile, LeBaron et al. (2018) found that students who did not have financial conversations with parents and grandparents wished that they had had open communication about financial stewardship. Jorgenson and Savla (2010) found that college-age students believed that their parents influenced their own financial attitude and behavior. Clarke et al. (2005) found that the financial role transfer takes place most frequently from parents in the home, rather than from sources outside the home. Financial literacy is influenced by the degree of sophistication found in one's family of origin: more specifically, a college-educated man whose parents had stocks and retirement savings is about 50 percentage points more likely to know about risk diversification than a woman with less than a high school education whose parents were not wealthy (Lusardi and Mitchell 2008). Hancock et al. (2013) found that early intervention in life affects student credit card debt activity by college age.

These family influences extend to future financial behavior. Van Rooij et al. (2011) found that individuals with lower financial literacy avoid investing in stocks; this finding is important, since most retirement planning has moved to privatized programs that are becoming increasingly more complex but which are rarely accompanied by financial education programs. Underinvestment in stocks would imply less-than-optimally diversified portfolios, which may lead to a lower level of wealth accumulation. Research has also found that the less financially literate individuals are more likely to borrow and accumulate less wealth. Stango and Zinman (2007) attributed higher borrowing levels to the inability to calculate interest rate payments, on account of a lack of financial literacy. Agarwal et al. (2009) found a relationship between financial literacy and the likelihood of making financial mistakes: the young and the elderly are more likely to make less-than-optimal financial decisions.

Lusardi and Mitchell (2008) found that women who are 50 or over and are approaching retirement age have generally undersaved for retirement; they attributed this to their lack of financial literacy. Meanwhile, Wagland and Taylor (2009) found no disadvantage on the part of women with regard to financial literacy. Many other researchers, however, have found there to be a gender-based gap in financial literacy (Chen and Volpe 2002; Clarke et al 2005; de Bassa Scheresberg 2013; Goldsmith and Goldsmith 1997; Lusardi et al. 2010; Worthington 2006). We expect that Wagland and Taylor (2009) arrived at a different result on account of their sample, which comprised high-achieving students that self-selected as financial and economics majors. Although means testing and multivariate logistic regression analysis in the previously mentioned studies indicated a gender-based difference, Hamacher (2001) suggested that at the individual level this finding is irrelevant, as differences between genders are much less pronounced than differences among people of the same gender.

Fonseca et al. (2012) attempted to explain the gender-based gap, hypothesizing that men specialize in a household's financial decision-making and are thus more likely to be concerned with financial skills acquisition. Their analytical results did not support this hypothesis; instead, the authors found financial specialization to be sensitive to the spouse's relative education levels. Chen and Volpe (2002) explained the gap by suggesting that women's financial confidence and enthusiasm levels are lower than those of their male counterparts; however, they did not explain why this might be the case. Goldsmith and Goldsmith (1997) also found a gender-based gap in financial confidence levels, but were able to close both this gap and a gap in objective literacy through a one-semester financial education treatment. Another possible explanation is that women are more risk averse than men, and so this behavioral context may affect their financial actions (Chen and Volpe 1998; Goldsmith and Goldsmith 1997; Goldsmith et al. 1997).

Much of the literature maintains the importance of math skills as a support for financial understanding; this makes sense, given that financial literacy is often defined in terms

of math ability (Worthington 2006). The questions developed by Lusardi and Mitchell (2008) that currently serve as the gold standard for measuring financial literacy are mathematical in nature. da Bassa Scheresberg (2013) found that those who rate themselves as "good at math" are less likely to engage in high-cost borrowing behavior and are more likely to have an emergency fund and retirement savings. Therefore, they found self-reported confidence in math ability to affect financial behavior. However, their analysis did not include any measure of actual math ability. It is not clear whether math ability and math confidence do in fact correlate. Cole et al. (2016) used difference-in-difference estimation to show that increased state math requirements result in greater financial literacy and financial behaviors: specifically, they found greater financial market participation, larger investment in income stocks, better credit management, and fewer home foreclosures.

There are psychological connections among confidence in a subject, participating in learning about that subject and, finally, overall market behaviors. If investment in financial literacy is endogenous, as Lusardi et al. (2017) suggested, then what are the mechanisms that determine the acquisition of financial literacy? Additionally, if financial literacy is presented as mathematical (or perceived as being mathematical), then investments toward increasing financial literacy will be influenced by confidence in financial literacy, and also by perceived confidence in math. The literature has examined the role of financial confidence on financial behaviors, but not math confidence.

Our study extends the literature by examining objective financial literacy—a factor that has been examined previously, albeit in a limited fashion. Allgood and Walstad (2016) used objective and perceived measures of financial literacy to identify which is better at predicting actual financial behavior; they found that consumers' perceived financial ability to be a better measure then their actual financial literacy at predicting "bad" financial behavior. This finding suggests that confidence can predict financial outcomes and not one's actual knowledge of finance. Robb (2017) also explored subjective measures of financial knowledge and found them to correlate positively with measures of well-being in college students. That study also found individuals with higher measures of financial self-efficacy to be less likely to drop classes. Additionally, Totenhagen et al. (2019), using a sample of cohabitating and married young adults, found individuals' own subjective (but not objective) financial knowledge to correlate with relationship satisfaction.

Mottola (2013), using National Financial Capabilities Study (NFCS) data, found a relationship between math confidence and credit card behavior. The author found that an increase in the self-reported measure of math ability reduces negative credit card behavior by as much as 3 percentage points. However, a limitation of that study is that it did not distinguish between math ability and math confidence. The difference in financial behavior might be due to attitudes towards financial literacy education or an interest in financial behavior; in turn, these attitudes might be culturally developed or stereotypes that influence behavior. Driva et al. (2016) found that stereotypes and attitudes influence gender-based differences in financial knowledge and behavior. Lührmann et al. (2015) found that general overconfidence impacts financial behaviors.

Although financial confidence and math ability have been shown to impact financial literacy and financial behavior, less attention has been given to the role of one's self-assurance in math ability and financial literacy. We contribute to the literature by controlling for math ability when examining the role of perceived math ability. Our interest was in whether one's self-efficacy in math has an impact on financial literacy, and whether that impact is similar to that of financial confidence. While we did not observe financial behavior, we did measure the relationship between math confidence and financial literacy.

## Conceptual Framework and Hypothesis

Individuals accrue financial knowledge by making investments in financial literacy education. Investments in education can be explicit (e.g., course work) or implicit (e.g., discussions, experiences, and informal education outlets). We assumed that individuals can choose their investment levels and decide between explicit or implicit financial education, or a combination the two. Jappelli and Padula (2013), Lusardi and Mitchell (2014), and Lusardi et al. (2017) provided life-cycle models that predict optimal levels of investment in financial knowledge. Their findings were that individuals would invest in financial literacy education up to the point that the marginal cost and marginal benefit of the investment in financial knowledge are in equilibrium. The optimal level of investment depends on the cost function associated with financial knowledge acquisition.

We postulated that individuals do not observe their actual financial knowledge cost function, but rather approximate the cost function based on the perceived effort required to acquire new knowledge. We assumed that the perceived effort negatively correlates with self-efficacy in math ability: an individual who is less assured in their math ability will estimate a higher marginal cost of investing in financial knowledge acquisition. That individual would find it optimal to invest less in accumulating financial knowledge and will consequently perform less favorably on a financial literacy assessment than those more confident in their math ability.

## Study Design

The current study sought to assess the overall level of financial literacy among a sample of college students and determine if financial literacy is impacted by either objective or perceived math ability, while controlling for gender. This study was implemented in economics courses taught at a state university, a regional university, and a liberal arts college—namely, University of Kentucky (UK), Northern Kentucky University (NKU), and Young Harris College (YHC), respectively. The study was administered to students in a variety of courses, ranging from introductory-level to upper-division ones. The data used in our study were drawn from a student survey and a knowledge assessment. Data collection began during the second week of classes, after the add/drop date. Information on students' actual math ability was collected using an objective math assessment comprising 10 SAT and ACT-based questions that centered on topics frequently covered in introductory economics. The remaining data were collected using a survey administered through Qualtrics. The survey included the "big five" assessment of financial literacy, and questions that asked participants to self-rate their confidence level in their math ability; responses were captured using a five-point Likert scale. The study was approved by the Institutional Review Board and deemed exempt. We did not offer the students an incentive to complete the survey, but the math assessment was designed as an in-class quiz. The quiz accounted for less than 1% of the overall course grade.

## Descriptive Statistics

### Demographics

Of the 671 students asked to complete the survey, 529 did so (participation rate: 79%). The participation rate by institution was 98% for NKU, 74% for UK, and 80% for YHC. There were also 105 non-respondents, 27 students who chose to opt out, and 10 students who started the survey but never completed it.

Table 1 contains student-level descriptive statistics. The final sample contained 529 students who completed the survey, of whom 43% were female and 57% male. The overall sample was categorized as 37% freshmen, 31% sophomores, 22% juniors, and 9% seniors. The average student age was 21.3 years. The sample was 80% White/non-Hispanic, 8% White/Hispanic, 7% Black, 4% Asian, and 1.4% other race. Approximately 17% of the students had transferred from other institutions, 68% were from each institution's state, and 6% were international students; moreover, 58% of the students lived on campus. The average final course grade was 81.8%, while the average score on the SAT/ACT math assessment (used to measure math ability) was 53.82%.

We used NFCS questions to test financial literacy. These questions are listed in Table 2, alongside the percentage of students who answered each question correctly.

An index value was created from the five questions used to assess the participants' financial literacy: quite simply, the financial literacy index is the sum of the number of correct answers. The average score in the sample was 2.928, which is comparable to the national average of 2.9885 derived in 2012 (Allgood and Walstad 2016) and the 2.99 average reported in 2015 (Al-Bahrani et al. 2019). The data suggest that, on average, men score more highly than women: the men answered 3.13 questions correctly, while the women answered 2.7 questions correctly. The difference in correct responses was statistically significant. We therefore found women to score lower on the financial literacy test than men, and this in turn suggested that the financial literacy gender-based gap develops by the time students are in college.

We found several similarities and differences among the students at the three institutions. The results of *t*-tests for the differences between the means of the characteristics for each institution and for the overall average indicated that the subsamples were similar. By surveying the student bodies of various institutions, we hoped to gain insights from a diversity of attitudes and perceptions. Additionally, we sought to derive a distributive sample with respect to age and experience by including both upper-division and introductory-level courses.

While there were more men than women in the sample, there were no statistically significant differences in gender proportions across institutions. The majority of the students at all three institutions were white (i.e., > 75%); Black students accounted for the next-largest racial group at NKU, and Hispanics represented the next-largest group at both YHC and UK. The differences in racial composition across institutions were not statistically significant, save for the notable lack of Asian students in the YHC sample. Transfer rates varied considerably among the three institutions: 27% of NKU participants had transferred from another institution, as had 15% of UK students and only 3% of YHC students. Additionally, campus residential rates were quite divergent: only 25% of NKU students lived on campus, while at UK and YHC, those numbers were 62% and 95%, respectively. NKU students were also most likely to have a job: 76% of the NKU students worked, while only 39% of the UK and YHC students did so. Perhaps this explains why the NKU students took slightly fewer hours per semester than the students at the other institutions. Additionally, YHC also had significantly more international students (18%) than

**Table 1** Descriptive statistics

| Variable | All | | NKU | | UK | | YHC | |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Female | 0.432 | 0.496 | 0.374 | 0.486 | 0.456 | 0.499 | 0.390 | 0.492 |
| Male | 0.567 | 0.496 | 0.617 | 0.488 | 0.544 | 0.499 | 0.610 | 0.492 |
| White/non-Hispanic | 0.798 | 0.402 | 0.804 | 0.399 | 0.784 | 0.412 | 0.864 | 0.345 |
| White/Hispanic | 0.080 | 0.271 | 0.037 | 0.191 | 0.089 | 0.285 | 0.102 | 0.305 |
| Black | 0.068 | 0.252 | 0.103 | 0.305 | 0.063 | 0.244 | 0.034 | 0.183 |
| Asian | 0.041 | 0.198 | 0.047 | 0.212 | 0.046 | 0.210 | 0.000 | 0.000 |
| Other race | 0.014 | 0.116 | 0.009 | 0.097 | 0.017 | 0.130 | 0.000 | 0.000 |
| Transfer | 0.165 | 0.372 | 0.271 | 0.447 | 0.156 | 0.363 | 0.034 | 0.183 |
| Instate | 0.677 | 0.468 | 0.748 | 0.436 | 0.645 | 0.479 | 0.746 | 0.439 |
| International student | 0.059 | 0.236 | 0.056 | 0.231 | 0.039 | 0.194 | 0.186 | 0.393 |
| On campus | 0.582 | 0.494 | 0.252 | 0.436 | 0.621 | 0.486 | 0.949 | 0.222 |
| Private school | 0.216 | 0.412 | 0.198 | 0.400 | 0.236 | 0.425 | 0.136 | 0.345 |
| First economics class | 0.587 | 0.493 | 0.462 | 0.501 | 0.718 | 0.450 | .0034 | 0.183 |
| College GPA of 0–0.99 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| College GPA of 1–1.99 | 0.014 | 0.116 | 0.000 | 0.000 | 0.020 | 0.141 | 0.000 | 0.000 |
| College GPA of 2–2.49 | 0.104 | 0.305 | 0.085 | 0.280 | 0.112 | 0.316 | 0.085 | 0.281 |
| College GPA of 2.5–2.99 | 0.223 | 0.416 | 0.283 | 0.453 | 0.196 | 0.398 | 0.271 | 0.448 |
| College GPA of 3–3.49 | 0.313 | 0.464 | 0.283 | 0.453 | 0.334 | 0.472 | 0.237 | 0.429 |
| College GPA of 3.5–4 | 0.348 | 0.477 | 0.349 | 0.479 | 0.337 | 0.473 | 0.407 | 0.495 |
| Job | 0.465 | 0.499 | 0.755 | 0.432 | 0.389 | 0.488 | 0.390 | 0.492 |
| Fin lit | 2.928 | 1.374 | 3.157 | 1.312 | 2.818 | 1.398 | 3.186 | 1.266 |
| Fin lit male | 3.131 | 1.346 | 3.934 | 1.251 | 3.005 | 1.409 | 3.333 | 1.069 |
| Fin lit female | 2.701 | 1.343 | 2.854 | 1.276 | 2.628 | 1.335 | 2.957 | 1.522 |
| Math | 0.991 | 0.097 | 0.991 | 0.096 | 0.989 | 0.105 | 1.000 | 0.000 |
| Freshman | 0.371 | 0.484 | 0.038 | 0.191 | 0.528 | 0.500 | 0.017 | 0.130 |
| Sophomore | 0.314 | 0.465 | 0.481 | 0.502 | 0.239 | 0.427 | 0.475 | 0.504 |
| Junior | 0.221 | 0.415 | 0.311 | 0.465 | 0.181 | 0.385 | 0.305 | 0.464 |
| Senior | 0.093 | 0.291 | 0.170 | 0.377 | 0.053 | 0.224 | 0.203 | 0.406 |
| Total no. of students | 529 | | 108 | | 362 | | 59 | |
| Percent of total sample | 100% | | 20% | | 68% | | 11% | |

*NKU* Northern Kentucky University, *UK* University of Kentucky, *YHC* Young Harris College

the other institutions (NKU, 5.9%; UK, 3.9%). The sample also varied across institutions in terms of category breakdown: at UK, the students were predominantly freshmen, YHC students were mostly seniors, and NKU students were mostly sophomores.

Using responses from the survey, we identified math self-efficacy ratings. In line with Harrison et al. (1997), the students were asked to use a five-point Likert scale to respond to the prompt "I am confident of my math ability." We identified students as having high self-efficacy in math ability if they responded with Agree (4) or Strongly Agree (5), and as having high math ability if their math scores were greater than the mean scores in the sample (Table 3).

Our sample was equally distributed between high and low perceived math ability, with 50.85% reporting high self-efficacy in math ability. However, men were more likely to report a higher perceived math ability relative to women, and differences in the means of the two groups were statistically significant in this regard. We found 55.70% of the male participants report high perceived ability. In the female sample, only 44.7% of females are considered having high perceived ability. We identified students as having high math ability if they scored above the mean on the math quiz, and found that men were more likely to score above the mean, relative to women. The overall correlation between actual and perceived math ability was low, at 25.9. The fact that the two measures did not correlate reduced multicollinearity concerns in regression analysis. For men, the correlation between math ability and math confidence was 26.5, while for women it was 22.5. Although the correlation was low, we found the correlation between actual and perceived math ability to be higher for men than for women; this also suggests that women's underestimation of their ability is more severe than men's over perception. We tested for statistical

**Table 2** Summary of results of the NFCS questions

| | Question[a] | Percentage of respondents who answered the question correctly (%) | Percentage of respondents who answered the question incorrectly (%) | Percentage of respondents who are male (%) |
|---|---|---|---|---|
| Q1 | Suppose you had $100 in a savings account and the interest rate was 2% per year. After five years, how much do you think you would have in the account if, you had left the money to grow? | 90.06 | 7.15 | 57.06 |
| Q2 | Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After one year, would you be able to buy more than today, exactly the same as today, or less than today with the money in this account? | 61.00 | 21.40 | 57 |
| Q3 | 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 | 53.94 | 11.22 | 56.70 |
| Q4 | True or False? A 15-year mortgage typically requires higher monthly payments than a 30-year mortgage, but the total interest over the life of the loan will be less | 73.13 | 8.86 | 56.70 |
| Q5 | If interest rates rise, what will typically happen to bond prices? | 29.49 | 39.39 | 57.17 |

[a]Each question has a response of "don't know". This response was not considered part of the incorrect response

**Table 3** Perceived and actual ability by gender

| | % of sample | % male | % female | *t*-stats: difference between male and female |
|---|---|---|---|---|
| High math perception | 50.95 | 55.70 | 44.74 | 2.50 |
| High math ability | 50.47 | 56.38 | 42.54 | 3.17 |
| Total no. of respondents | 526 | 298 | 228 | |

differences of high math ability and high math perception; we found that men were statistically more likely to be in both the high math ability category and the high perceived math ability category.

## Methods

In this study, we focused on the determinants of students' financial literacy. We estimated the following equation using an ordered probit.

$$Y_j = \beta_0 + \beta_1 X_j + \beta_2 \mu_j + \beta_3 a_j + \epsilon_j \quad (1)$$

where vector $X_j$ includes control variables that measure student $j$'s demographic and educational attributes. We controlled for variables in line with the literature. Vector $\mu_j$ measures student's $j$'s perceived confidence measures, and vector $a_j$ measures math ability. The dependent variable $Y_j$ is student $j$'s number of correctly answered NFCS questions. The dependent variable could take one of six possible values, ranging from 0 to 5. We employed an ordered probit methodology because the dependent variable is ordinal and, therefore, ordinary least squares assumptions of a continuous random variable were violated. Our methodological approach was similar to those of Chen and Volpe (2002) and Allgood and Walstad (2016).

Ordered probit and probit models are similar, with the exception of possible outcomes for the dependent variable. A probit model is used when the dependent variable has two possible outcomes—usually when estimating the probability of outcomes for a dummy variable. An ordered probit is applied when modeling outcomes exceed 2, and when the outcomes are ordinal. Such estimation allowed us to isolate

the marginal effect of high math self-efficacy and high math ability for every possible outcome. Thus, this methodology allowed us insights into the role of perceived and actual ability across the possible levels of financial literacy.

## Results and Discussion

Table 4 presents estimates of high ability and high perception with regard to financial literacy, for the overall sample [column (1)] and then by gender [columns (2) and (3)]. When estimating student financial literacy for the overall sample, the data suggested that men have higher financial literacy scores. Therefore, holding everything else constant, men are more financial literate than women. We also found there to be a race-based financial literacy gap: Black students scored lower on the financial literacy exam than white students. This college-level race-based financial literacy gap is consistent with the national results and findings reported by Al-Bahrani et al. (2019). There were no statistically significant differences between white students and other races.

**Table 4** Ordered probit estimation of financial literacy score using two categorical groups: high vs. low ability, and high vs. low perception

| | (1) Full sample | (2) Male | (3) Female |
|---|---|---|---|
| High math perception | 0.28† (0.10) | 0.12 (0.14) | 0.43† (0.16) |
| High math ability | 0.25† (0.10) | 0.30† (0.14) | 0.24 (0.16) |
| Male | 0.23† (0.10) | | |
| Age | −0.01 (0.03) | −0.00 (0.03) | −0.04 (0.07) |
| Hispanic | −0.08 (0.18) | −0.23 (0.22) | 0.24 (0.30) |
| Black | −0.39† (0.20) | −0.48 (0.32) | −0.14 (0.27) |
| Asian | −0.33 (0.29) | −0.23 (0.50) | −0.41 (0.36) |
| Other | −0.64 (0.44) | −0.35 (0.50) | −1.65 (1.09) |
| Sophomore | −0.08 (0.13) | −0.03 (0.18) | −0.09 (0.20) |
| Junior | −0.04 (0.16) | −0.04 (0.22) | −0.03 (0.26) |
| Senior | 0.27 (0.23) | 0.46 (0.29) | −0.44 (0.50) |
| Private school | 0.11 (0.12) | 0.23 (0.16) | −0.06 (0.20) |
| Job | 0.10 (0.10) | 0.21 (0.14) | −0.05 (0.16) |
| First economics course | −0.42† (0.12) | −0.34† (0.16) | −0.62† (0.18) |
| Courses this semester | 0.04 (0.07) | −0.00 (0.09) | 0.09 (0.10) |
| International student | −0.53† (0.26) | −0.79† (0.34) | −0.32 (0.44) |
| Transfer student | 0.14 (0.15) | −0.05 (0.18) | 0.70† (0.30) |
| College cumulative GPA | 0.08 (0.05) | 0.05 (0.07) | 0.11 (0.08) |
| Reported high school GPA | −0.01 (0.04) | 0.15 (0.15) | −0.03 (0.05) |
| No. of observations | 478 | 273 | 205 |

Standard errors are in parentheses

†$p < 0.10$

Furthermore, relative to domestic students, international students scored lower on the financial literacy exam; it is difficult to determine whether this was due to financial literacy or language limitations. Lusardi and Mitchell (2011) found performance on financial literacy assessments to be sensitive to how questions are structured, and so we expected variation in performance based on native language; however, we did not collect data on first language and therefore could not test for this hypothesis. We did not find class standing (e.g., freshman versus senior) to impact financial literacy, and this implied there is no evidence that students gain financial literacy as they progress through college. Similarly, we found age to be a statistically insignificant factor. Students with jobs and those who had attended private high schools did not do better than their counterparts. We expected the coefficient on first-time economic students to capture most of the variation of class standing and age: we found that students taking economics for the first time scored lower than those who had previously taken an economics course. Since our sample included foundational and upper-level courses, then our measure of first-time student measured the difference between students earlier in their career and more experienced students.

Our variables of interest were perceived math ability and actual math ability. Students that scored above the mean on the math test scored better on the financial literacy exam. More importantly, students reporting higher perceived math ability had higher financial literacy scores. This result does not imply causation; it merely highlights a correlation between financial literacy and a student's confidence in their math ability. Students might be more likely to guess when they are confident, or more likely to tackle the problem. Students with low levels of academic or math self-efficacy may also avoid learning about financial topics, for fear that the concepts will be out of reach. One limitation of the current study is that we did not control for socioeconomic differences; doing so would be worthwhile, as there might be a correlation between household income and financial literacy (Lusardi et al. 2010). Jappelli and Padula (2013) developed a model that indicates that the decision to invest in financial literacy is a function of wealth, and so we expected socioeconomic factors to influence the decision to invest in financial literacy. We added a dummy variable to control for whether a student attended a private high school, as a measure of family wealth; however, this indicator variable was not found to be statistically significant.

We repeated the estimation for men and women and report them in specifications 2 and 3. While perceived math ability was significant for women's financial literacy estimate, math ability was not a significant indicator for women. For men, math ability did impact the financial literacy score, but perceived math ability did not. Holding all else constant, men who were more confident in their math ability did not

do better on the financial literacy assessment than men with lower math self-efficacy. However, for women, increased perceived math ability correlated with higher financial literacy. Women with a higher self-efficacy of math ability, regardless of actual ability, did in fact score higher on the financial literacy exam. On the other hand, women with higher math ability did not do better than those with lower math ability.

To further understand the differences in our gender-based estimations, we present in Figs. 1 and 2 the marginal effects by actual and perceived ability, respectively. Figure 1 presents the marginal effects of the high math ability across possible financial literacy outcomes, while presenting for both the male and female subsamples. For men, we found the marginal effect point estimate to be negative for the dummy variable at outcomes associated with answering zero to three questions correctly. This implies that men with high math ability were less likely to score 0, 1, 2, or 3 than men with lower math ability. However, the coefficients were not statistically significant. At the higher end of the financial literacy

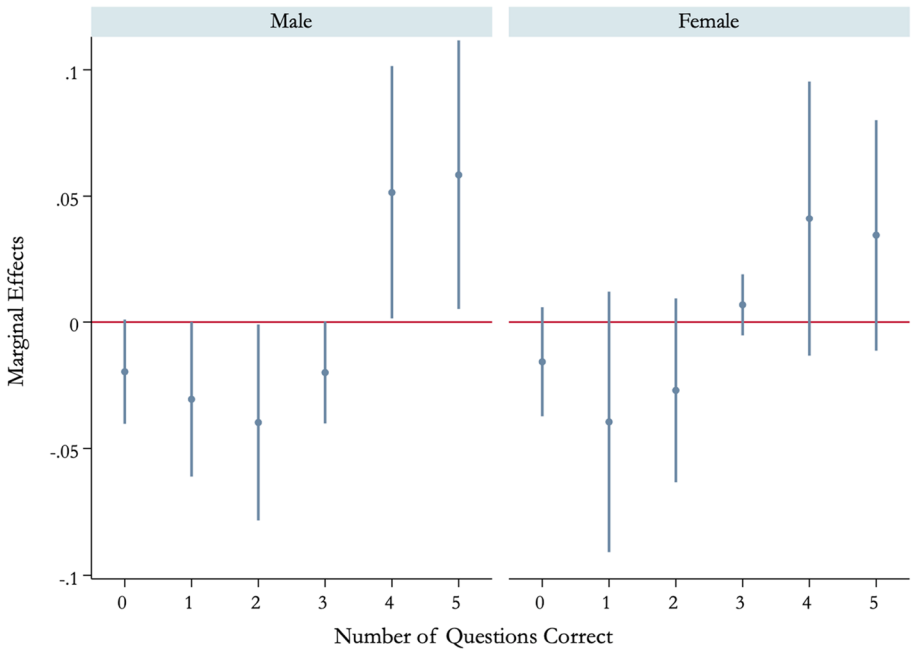


**Fig. 1** Marginal effects of high math ability, across the possible financial literacy outcomes

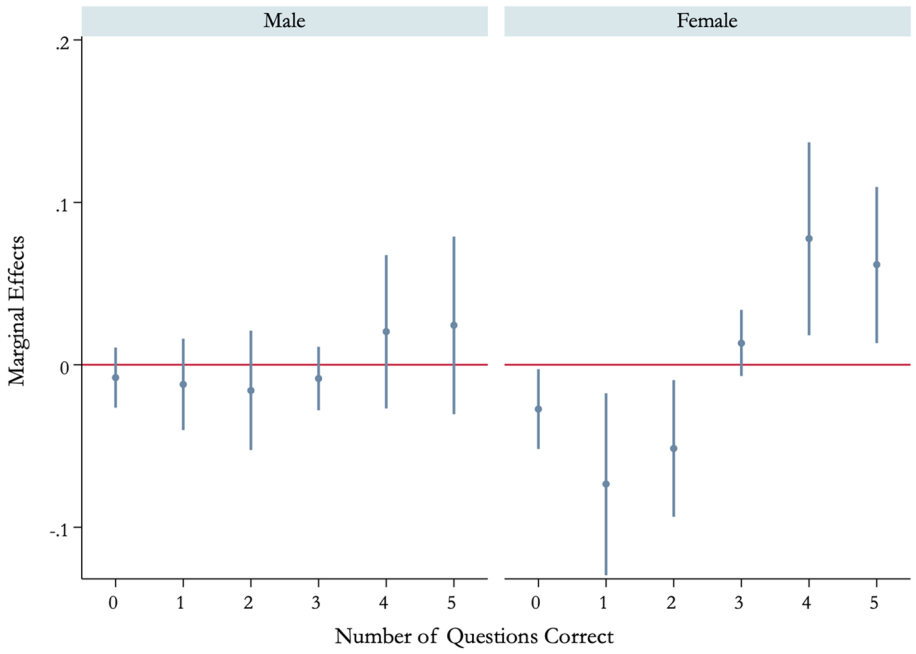


**Fig. 2** Marginal effects of high math ability (perceived), across the possible financial literacy outcomes

spectrum, we saw that high math ability was positive and statistically significant; this implied that those with higher ability were more likely to score 4 or 5 on the financial literacy assessment, relative to men with low math ability. We also present the high math ability marginal effects coefficient for the female subsample, where we can see larger standard errors. In this sense, we found no evidence that math ability and financial literacy correlate.

Figure 2 presents the marginal effects for perceived math ability for men and women. For men, we found no evidence of a relationship between perceived math ability and financial literacy. We did, however, find evidence of such a relationship for women: those with high perceived ability had lower probabilities of scoring on the lower end of the financial literacy spectrum, and were more likely to exhibit higher financial literacy. With the exception at the mean, we found the relationship between self-efficacy and financial literacy to be statistically significant.

Our results presume that perceived and actual math ability do not correlate. In Table 5, we present the results of our specification from isolating perceived and actual math ability. In column (1) we include all variables from Eq. 1 but exclude math ability. (We report only the variables of interest.) We found the coefficient on perceived math ability to be both positive and significant. Similarly, in column (2), we exclude perceived math ability and isolate math ability; we found a positive and significant coefficient. We repeated our specification separately for the male and female subsamples [columns (3)–(4) and (5)–(6), respectively]. The results for the male subsample remain the same, but for the female subsample, math ability becomes significant when isolated. We associate the results to be influenced by omitted variable bias. This implies that other research that does not control for math perception would suffer for omitted variable bias and would overestimate the effect of math ability on financial literacy. This bias is larger for females. The visuals in Figs. 1 and 2 also distinguish the impacts of perceived and actual math ability for both men and women.

While we found evidence that women's financial literacy relates to their perceived math ability, we employed another robustness check. We estimated our model using Allgood and Walstad's (2016) confidence and ability categories. We split the students into four categories—namely, a) high ability and high perception, (b) high ability and low perception, (c) low ability and high perception, and d) low ability and low perception. We defined a student as being in the High Ability and High Perception category if they scored above the mean for all math scores, and if they responded with "Agree" or "Strongly Agree" to the math confidence question. Table 6 describes each of the categories.

Using the Low Ability and Low Perception group as a comparison group, we derived a deeper understanding of the impact of perceived and actual math ability on financial literacy. Table 7 analyzes the full sample and the male and female subsamples; the results therein are consistent with those in Table 4. Students with high math ability and high perceived math ability outperformed those in the comparison groups. The results further emphasize that, for women in particular, self-efficacy works as the main indicator of financial literacy.

In the first specification we found that both those in the high ability and high perception group and those in the low ability and high perception group had higher financial literacy than those in the low ability and low perception group. We additionally found that the performance of individuals in the high ability and low perception group was similar to that of individuals in the low ability and low perception group. Thus, the difference in outcomes was driven by perception. We repeated our estimate for men and found that only high math ability increased the financial literacy score. Finally,

**Table 5** Ordered probit estimation variation in specifications and sample

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| High math perception | 0.34† (0.10) | | 0.19 (0.14) | | 0.48† (0.15) | | 0.42† (0.15) |
| High math ability | | 0.31† (0.10) | | 0.33† (0.14) | | 0.33† (0.15) | 0.18 (0.15) |
| High math perception × male | | | | | | | −0.26 (0.20) |
| High math ability × male | | | | | | | 0.14 (0.20) |
| Male | 0.27† (0.10) | 0.26† (0.10) | | | | | 0.30† (0.16) |
| No. of observations | 478 | 478 | 273 | 273 | 205 | 205 | 478 |
| Sample notes | | | | | | | |
| Includes controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sample | Full sample | Full sample | Male sub-sample | Male sub-sample | Female sub-sample | Female sub-sample | Full sample |

Standard errors are in parentheses

†$p < 0.10$

**Table 6** Description of confidence and ability categories used as controls in ordered probit model

| Category | Confidence description | Ability description | N |
|---|---|---|---|
| High confidence and high ability | Responded "agree" or "strongly agree" on rating of math confidence | Scored *above* the mean on math assessment | 170 |
| High confidence and low ability | Responded "agree" or "strongly agree" on rating of math confidence | Scored *below* the mean on math assessment | 97 |
| Low confidence and high ability | Responded "strongly disagree," "disagree," or "neither agree or disagree" on rating of math confidence | Scored *above* the mean on math assessment | 99 |
| Low confidence and low ability | Responded "strongly disagree," "disagree," or "neither agree or disagree" on rating of math confidence | Scored *below* the mean on math assessment | 163 |

**Table 7** Ordered probit estimation of financial literacy using four categorical groups: high to low ability and perception

| Variables | (1) Full sample | (2) Male subsample | (3) Female subsample |
|---|---|---|---|
| High ability and high perception | 0.53† (0.13) | 0.42† (0.18) | 0.67† (0.20) |
| High ability and low perception | 0.21 (0.15) | 0.28 (0.21) | 0.25 (0.22) |
| Low ability and high perception | 0.24† (0.14) | 0.10 (0.21) | 0.44† (0.21) |
| Male | 0.23† (0.10) | | |
| Age | −0.01 (0.03) | −0.00 (0.03) | −0.04 (0.07) |
| Hispanic | −0.08 (0.18) | −0.23 (0.22) | 0.24 (0.30) |
| Black | −0.39† (0.20) | −0.48 (0.32) | −0.14 (0.27) |
| Asian | −0.33 (0.29) | −0.22 (0.50) | −0.41 (0.36) |
| Other | −0.64 (0.44) | −0.35 (0.50) | −1.66 (1.10) |
| Sophomore | −0.08 (0.13) | −0.04 (0.18) | −0.09 (0.20) |
| Junior | −0.04 (0.16) | −0.04 (0.22) | −0.03 (0.26) |
| Senior | 0.26 (0.23) | 0.46 (0.29) | −0.44 (0.50) |
| Private school | 0.10 (0.12) | 0.22 (0.16) | −0.06 (0.20) |
| Job | 0.10 (0.10) | 0.21 (0.14) | −0.05 (0.16) |
| First economics course | −0.43† (0.12) | −0.34† (0.16) | −0.62† (0.18) |
| Courses this semester | 0.04 (0.07) | −0.00 (0.09) | 0.09 (0.10) |
| International student | −0.53† (0.26) | −0.79† (0.34) | −0.32 (0.44) |
| Transfer student | 0.14 (0.15) | −0.05 (0.18) | 0.71† (0.30) |
| College cumulative GPA | 0.08 (0.05) | 0.05 (0.07) | 0.11 (0.08) |
| Reported high school GPA | −0.01 (0.04) | 0.15 (0.15) | −0.03 (0.05) |
| No. of observations | 478 | 273 | 205 |

Standard errors are in parentheses

†$p < 0.10$

in the female subsample results, we found that individuals in the high-perception categories had higher scores on the financial literacy test. While there might be concerns with multicollinearity in the female subsample, our results indicate that the impact of perception on outcomes is confirmed.

## Study Limitations

In addition to the multicollinearity concern, the current study has several limitations that we wish to highlight; we encourage future research that addresses these issues. Our sample was limited to three institution of higher education in the southeastern United States. Our attempt to diversify our sample by including a large state university, a regional university, and a liberal arts college cannot go far enough to create a generalizable sample. Furthermore, our sample was limited to students enrolled in economics courses. As such, this sample of students is not reflective of the general population, and so our ability to generalize our results is limited. We encourage future research to include students from a wider range of disciplines.

Furthermore, our study relies on one measure of perceived math ability. It would be interesting to determine whether the results of this research would hold if one were to include a variable that comprises several confidence

measures. Additionally, rather than limit the measure of math perception, there might be reasons to consider perceptions in other fields (or overall confidence) and their impact on financial literacy (It would be interesting to test for the relationship between overall confidence, math confidence, and financial literacy, for example). Finally, while our results are helpful in explaining the gender-based financial literacy gap, more research is needed to examine the impact on financial outcomes. Finally, since we found evidence that the gender-based financial literacy gap is in already in place by college age, it would beneficial to examine the gender financial literacy gap at earlier education levels or at younger ages.

## Conclusion

In this study we examined the early determinants of financial literacy. Previous research explained this gap as possibly deriving from household specialization outcomes, where men are more likely to manage the household finances. However, our findings indicate that the gender-based financial literacy gap is already present at college age, before household specialization roles have been defined. We do expect that family influences, biases in the education system, or cultural norms potentially determine investment in financial knowledge.

Research results have indicated that in the United States, knowledge of financial concepts is universally low. Previous studies provided evidence of a link between financial confidence and financial literacy. Additionally, many studies (Chen and Volpe 2002; Goldsmith and Goldsmith 1997; Lusardi et al. 2010; Volpe et al. 1996; Worthington 2006) indicated a gender-based gap in financial literacy that may impede women's abilities to save and invest well. While our results align with those of previous studies and provide further evidence of a gender-based financial literacy gap, we extended the existing body of knowledge by establishing a link between perceived and actual math ability, and financial literacy. Specifically, we found that math ability increases financial literacy for men but not for women; we also found that math self-efficacy increases financial literacy for women but not for men.

Further research must be done to ascertain how perceived and actual math ability affect the marginal cost of investing in financial literacy, and why the effects for men and women differ. It is notable that our data suggestive of these links were collected among young college students, as the results indicated that these effects were established before most individuals had really acquired experience in major financial responsibility and decision-making—that is, while these differences may be education and/or culture-based, they are not experiential.

Our study results suggest that efforts devoted to adjusting financial behavior through financial literacy must focus on the role of perceived and actual math ability in financial literacy acquisition. Math plays a large role in the understanding of financial industry. To generate interest in financial behaviors, especially among women, efforts must be made to increase math confidence levels, especially in childhood. College-level intervention could help, but as our results suggested, college age might be too late for certain groups. Danes and Haberman (2007) highlighted differences in knowledge acquisition between teenage men and women, and they found that women are more likely to engage in discussion concerning finances through a financial planning curriculum. Resources devoted earlier in the education system to build math confidence can promote increased involvement by women in financial behavior and potentially close the gender-based financial literacy gap. Adult and college-level financial education might be a little too late to help minimize the gender financial literacy gap. Most importantly, our findings provide evidence that the gender-based financial literacy gap appears at early ages and cannot be explained by models that leverage the household division of labor.

### Compliance with Ethical Standards

**Ethical Approval** All procedures performed within the study that involved human participants were in accordance with the ethical standards of the Young Harris College Institutional Review Board (Reference No. 2015-12) and with the 1964 Helsinki Declaration. The study was considered exempt by Young Harris and was also reported to the IRB at Northern Kentucky University and the University of Kentucky. This study did not involve any animal research performed by any of the authors.

**Informed Consent** Informed consent was obtained from all individual participants included in the study.

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