

Financial Education, Age, and Gender: A Mixed-Effects Study of Financial Literacy in Japan*

Chikafumi Nakamura

Chuo University

E-mail: nakamura99r@g.chuo-u.ac.jp

ABSTRACT

This study investigates how formal and household financial education shape adult financial literacy in Japan using nationally representative surveys from 2016 to 2022 and linear mixed-effects models, allowing education effects to vary across age cohorts. The results show that formal education programs yield the largest gains in early adulthood, but these effects diminish with age, which is consistent with the learning-decay mechanism. A supplementary analysis focusing on knowledge-based literacy clarifies that formal education primarily strengthens the cognitive core of literacy. Additionally, this cognitive benefit remains comparatively stable across age groups. Gender differences are pronounced: women start with lower baseline literacy yet display stronger and more persistent gains, indicating that financial education is an equalizing mechanism to mitigate gender disparities. Overall, financial education effects are strongest in youth but fade without continued reinforcement, underscoring the importance of sustained, inclusive, and gender-sensitive financial learning throughout adulthood.

Key words: Financial literacy, Financial education, Financial knowledge

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1. Introduction

This study investigates the nexus between financial education and financial literacy in Japan. This study accounts for individuals' life experiences and aging, and assesses the magnitude and dynamics of this relationship.

In the wake of successive financial crises, enhancing financial literacy emerged as a key policy priority in the contemporary global economy (OECD, 2015). However, Japan's financial literacy levels remain comparatively low by international standards. A comparison of correct-response rates to harmonized financial-knowledge items in OECD and U.S. surveys reveals that Japan lags behind Germany, the United Kingdom, and the U.S. (Central Council for Financial Services Information, 2016). This pattern is persistent. Subsequent surveys (Central Council for Financial Services Information, 2019, 2022) corroborate these findings, underscoring the enduring challenge for Japan.

In response, the Financial Services Agency convened the Study Group on Financial and Economic Education in 2012 and, in 2015, produced the "Financial Literacy Map," a framework that systematizes financial literacy and provides strategic guidance for educational initiatives. Moreover, revisions to the National Courses of Study made financial education compulsory in schools beginning in April 2022.

However, the extent to which these educational interventions translate into tangible improvements in financial literacy remains unclear. Most empirical research examines the demographic and socioeconomic determinants of financial literacy or their associations with financial behavior. Rigorous evaluations of formal financial education remain scarce, particularly those scrutinizing school-based programs in Japan (Lusardi & Mitchell, 2014; Kaiser & Menkhoff, 2020).

Accordingly, this study assesses the effect of financial education on financial literacy in Japan. A key empirical challenge is that the relationship between age and financial literacy is nonlinear and the effect of education may vary across life stages. A linear mixed-effects model addresses both issues; it flexibly captures age-related differences in baseline literacy while simultaneously allowing the education effect to differ across age groups. This approach yields a richer picture of how educational gains evolve over the course of life than conventional regression methods, which impose uniform effects. Employing this framework, we estimate the relationship between financial education and financial literacy while controlling for demographic and socioeconomic attributes.

2. Literature Review

Before presenting the empirical analysis, we provide a concise review of the literature on the determinants of financial literacy and clarify how this study extends this line of inquiry.

A seminal contribution is Lusardi and Mitchell (2014), who synthesize the theoretical and empirical evidence on financial literacy and document systematic associations with demographic characteristics such as age, gender, educational attainment, race, income, and employment status. For Japan, Kadoya and Khan (2020a, 2020b) employ nationally representative data and show that demographic characteristics, socioeconomic attributes, and behavioral factors, such as prior financial difficulties and the use of financial information, are significantly correlated with financial literacy levels.

Evidence on whether financial education enhances financial literacy is mixed. A meta-analysis by Fernandes, Lynch, and Netemeyer (2014) finds that the average effect of financial education on financial knowledge is extremely small and decays rapidly over time. In contrast, Kaiser and Menkhoff (2020), using a meta-analysis of school-based experiments, report sizable positive effects, although they also acknowledge temporal attenuation. Yamori and Ueyama (2017) draw on an original web survey in Japan, and after controlling for demographic factors, identify a significant positive effect of financial education. Using the 2016 Financial Literacy Survey administered by the Central Council for Financial Services Information, Okamoto and Komamura (2021) reach a similar conclusion, but identify gender heterogeneity: the effect is significant for women but not for men. Conversely, Yoshino, Morgan, and Trinh (2017) analyze the same dataset and find no gender differences in overall financial literacy levels.

The time elapsed since instruction is a plausible source of these disparate findings and poses two methodological challenges. First, gains from financial education may not persist; knowledge and skills acquired immediately after instruction can dissipate over time passes (Fernandes et al., 2014; Kaiser & Menkhoff, 2020). Consequently, the measured effects depend on the observation window, complicating any assessment of the long-run impacts. Second, the relationship between financial literacy and age is inherently nonlinear. Numerous studies (e.g., Lusardi & Mitchell, 2014; Kadoya & Khan, 2020a; Okamoto & Komamura, 2021) show that financial literacy rises from youth through middle age and declines thereafter. Taken together, these issues make it difficult to disentangle age effects from educational impacts within a simple regression framework.

To address these limitations, this study adopts a novel modeling strategy that explicitly captures age-related nonlinearity and allows the effect of education to vary over time. The novelty of this research lies in this approach, and the findings of this study contribute to the body of financial literacy research.

3. Data and Methodology

Building on the previous literature, we draw on microdata from the Financial Literacy Survey administered by the Institute for the Promotion of Financial and Economic Education.¹ This

section first details the dataset and then delineates the study hypotheses, together with the mixed-effects modeling framework employed in the empirical analysis.

3.1. Data

Since 2016, the Japan Financial Literacy and Education Corporation (J-FLEC), formerly the Central Council for Financial Services Information, has administered the Financial Literacy Survey every three years to gauge the financial literacy of Japanese residents aged 18 years and older. The web-based survey was conducted in 2016, 2019, and 2022, employing items drawn from the Financial Literacy Map and sampling adults aged 18–79 years in proportions that closely mirror the national population structure.² To ensure comparability across waves, the 53 questions remain identical in each round. As the same respondents were not tracked over time, the data lack a panel structure, precluding the use of panel-data estimation techniques.

Beyond the core literacy items, the questionnaire contains numerous measures of the respondents' financial behaviors and attitudes. As these traits may influence literacy outcomes, we control for them in the empirical analysis. Specifically, we conduct an exploratory factor analysis of the behavioral items and include the resulting factor scores as covariates. Table 1 presents the questions used in the factor analysis.

Prior to factor extraction, we computed the Kaiser–Meyer–Olkin (KMO) measure³ of

Table 1. Factor analysis results

Item	Factor 1	Factor 2
Q1-1. Before purchasing something, I consider whether I can afford it.	−0.28	0.18
Q1-2. I pay my bills on or before the due date.	−0.40	0.14
Q1-3. <i>Herding bias</i> (peer-conformity bias).	0.18	0.08
Q1-4. I set long-term saving plans and make efforts to achieve them.	−0.45	0.28
Q1-5. I feel greater satisfaction spending money now than saving for the future.	0.60	0.11
Q1-6. I tend to leave tomorrow's matters until tomorrow.	0.72	0.07
Q1-7. I pay close attention to the management and investment of my money.	−0.44	0.31
Q1-8. I feel that I have borrowed too much money.	0.54	0.06
Q1-9. I accept that occasional losses in investments or deposits are unavoidable.	0.14	0.13
Q1-10. <i>Present-bias</i> (myopic behavior bias).	0.29	0.07
Q3-1. I keep track of the amount of my monthly income.	0.03	0.63
Q3-2. I keep track of the amount of my monthly expenditures.	0.00	0.69
Q11. I have secured living expenses for three months.	−0.41	0.17

Note. We use the original coding from the J-FREC questionnaire. Q1 items are measured on a five-point ordinal scale (1 = “applies to me,” 5 = “does not apply to me”). Q3 items are coded 1 = “aware” and 2 = “unaware.” Q11 is coded 0 = “secured,” 1 = “otherwise.” Therefore, positive factor loadings on Q1 items indicate that higher factor scores are associated with disagreement (i.e., more favorable financial behavior).

sampling adequacy. We obtain a value of 0.77, indicating that the data are well suited for factor analysis. A parallel analysis recommended retaining two factors. Using principal-factor extraction⁴ with oblimin rotation, we derived the loadings reported in Table 1. Accordingly, we label Factor 1 “Planning” and Factor 2 “Household Management,” and use their factor scores in the subsequent analyses.

Table 2 presents the descriptive statistics for all study variables, including the two behavioral factors. We rescale the ordinal items such that 0 represents the lowest category and higher integers increase proportionally, whereas binary items are coded 1 for “yes” and 0 for “no.” To mitigate potential satisficing, we exclude respondents who selected “don’t know” on all 25 financial-literacy items.⁵

Table 2. Descriptive statistics for the variables used in the analysis

Variable	N	Mean	SD	Min	Max
Financial Literacy Score	79,545	56.19	27.72	0	100
Financial Knowledge Score	79,545	13.96	8.75	0	28
Educational Opportunities					
Formal financial education Experience	79,545	0.07	0.25	0	1
Household Financial-Education Experience	79,545	0.20	0.40	0	1
Behavioral Characteristics/Attitudes					
Perceived Need for Formal financial education	79,545	0.68	0.47	0	1
Factor 1: Planning	79,545	0	0.88	-3.37	1.77
Factor 2: Household Management	79,545	0	0.82	-1.43	3.18
Loss-Aversion Tendency	79,545	0.76	0.42	0	1
Herding (Peer-Alignment) Bias	79,545	0.21	0.50	0	2
Present-Bias (Myopic Behavior)	79,545	0.79	0.89	0	2
Experience of Financial Troubles	79,545	0.07	0.25	0	1
Interest in Economic Information	79,545	2.29	1.55	0	4
Demographic/Socioeconomic Attributes					
Female (1 = Yes)	79,545	0.51	0.5	0	1
Age (seven 10-year bands, 1–7)	79,545	4.5	1.7	1	7
Government Employee (1 = Yes)	79,545	0.04	0.19	0	1
Student (1 = Yes)	79,545	0.05	0.21	0	1
Education: Compulsory Only (1 = Yes)	79,545	0.03	0.17	0	1
Education: University or Higher (1 = Yes)	79,545	0.43	0.49	0	1
Asset Holdings	79,545	0.59	0.8	0	2
Mortgage Holding	79,545	0.21	0.40	0	1
Survey Year Dummies					
Year 2019	79,545	0.31	0.46	0	1
Year 2022	79,545	0.37	0.48	0	1

The dependent variables are the Financial Literacy and Financial Knowledge Scores. We construct the Financial Literacy Score (maximum = 100) from 25 correct or incorrect items, with each correct answer worth four points. These items cover the eight domains specified in the Financial Literacy Map: household budget management, life planning, financial transactions, financial and economic fundamentals, insurance, loans and credit, asset building, and use of external information.

As a supplementary measure specifically for financial knowledge, we construct the Financial Knowledge Score using items corresponding to those in the U.S. FINRA Foundation's National Financial Capability Study, which operationalizes the "Big Five" financial literacy frameworks (Lusardi & Mitchell, 2011). The score comprises seven items (maximum = 28): interest rate calculation, compound interest, inflation, mortgages, risk diversification, bond prices, and the rule of 72.⁶

Among the explanatory variables, the key variables for our hypotheses related to financial education experience. The survey asked respondents about their experience with formal financial education (in schools, universities, or workplaces) and household financial education, which we code as dichotomous variables.⁷ As the effect of formal education may vary depending on the presence or absence of household education, we also include an interaction term between the two.

To control behavioral traits and attitudes, we incorporate

- two latent factors identified earlier—*Planning* and *Household Management*;
- an indicator of the perceived need for school-based financial education (1 = agree, 0 = otherwise);
- three behavioral-economics measures: a loss-aversion dummy (1 = "would not invest," 0 = "would invest"), and present bias (myopic behavior) and herding (peer alignment) coded as ordinal three-level variables and entered linearly (2 = "agree," 1 = "somewhat agree," 0 = otherwise), such that higher values indicate stronger bias;
- a dummy for experience of financial trouble (1 = yes, 0 = no); and
- an ordinal measure of interest in economic information (0 = never, ..., 4 = almost every day), where we drop respondents choosing "other" (0.1 percent).

The remaining covariates capture the respondents' demographic and socioeconomic characteristics. Except for age, which we classify into seven 10-year brackets, and asset holdings, which we group into three brackets,⁸ all variables are binary indicators. As the dataset comprises repeated cross-sections, we add year dummies (2016 reference) to absorb period effects. For all covariates, the variance inflation factor is less than 2 ($VIF < 2$), suggesting no appreciable multicollinearity among the predictors.

3.2. Methodology

To assess how the impact of school-based financial education evolves across the life course, the intercepts and education effects must vary with age. A standard linear regression that includes age as merely a covariate imposes constant slopes, and thus cannot accommodate such heterogeneity. Therefore, we estimate a linear mixed-effects model⁹ that combines fixed effects (shared by all observations) with random effects (specific to age strata).

Let Y_{ij} denote the Financial Literacy Score of individual i in age group j . The model is

$$Y_{ij} = \beta_0 + \sum_{k=1}^p \beta_k X_{ijk} + (b_{0j} + b_{1j} X_{ij1}) + \varepsilon_{ij},$$

$$\begin{pmatrix} b_{0j} \\ b_{1j} \end{pmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{b_0}^2 & \rho \sigma_{b_0} \sigma_{b_1} \\ \rho \sigma_{b_0} \sigma_{b_1} & \sigma_{b_1}^2 \end{pmatrix} \right),$$

where β_0 denotes the fixed-effects intercept, β_k the fixed-effect coefficient for covariate X_{ijk} , b_{0j} the group-specific random intercept, b_{1j} the group-specific random slope on X_{ij1} , and ε_{ij} the idiosyncratic error term.

By incorporating random slopes in addition to random intercepts, the model accommodates group-specific variation in the effects of explanatory variables, thereby providing a more flexible representation of the data structure than a fixed-effects-only specification. We conduct parameter estimation via restricted maximum likelihood (REML), which first integrates random effects and then estimates the fixed effects.¹⁰

We must determine whether random intercepts accompany random slopes empirically. Accordingly, we compared two specifications using a likelihood-ratio test: (i) a random-intercept model with age groups as the clustering factor and (ii) a random-intercept-and-slope model in which we allow the slope for school-based financial-education experience to vary by age group. The likelihood-ratio test indicated a statistically significant improvement in fit at the 1 percent level,¹¹ so the ensuing analysis adopts the linear mixed-effects model with both random intercepts and random slopes.

4. Empirical Results

Table 3 reports the estimation results for the Financial Literacy Score in the full sample and, as in previous studies, in gender-specific subsamples. Because ordinary R^2 cannot be computed for models with random effects, we present the conditional coefficient of determination (R_c^2)

Table 3. Mixed-effects model results for Financial Literacy Scores

Variable	Full		Male		Female	
	β	SE	β	SE	β	SE
Fixed-effects						
Intercept	35.79***	(2.60)	35.16***	(2.36)	34.01***	(2.81)
Formal financial education	4.98***	(1.07)	3.47***	(1.20)	7.75***	(1.03)
Household financial education	4.41***	(0.21)	3.93***	(0.33)	4.86***	(0.28)
Need for financial education	16.13***	(0.17)	16.70***	(0.25)	15.26***	(0.24)
Factor 1: Planning	5.83***	(0.11)	6.44***	(0.16)	5.09***	(0.15)
Factor 2: Household management	-0.22**	(0.11)	-0.41***	(0.16)	-0.10	(0.15)
Loss-aversion tendency	-5.51***	(0.20)	-5.80***	(0.25)	-4.81***	(0.31)
Present-bias (myopic) behavior	2.00***	(0.11)	3.17***	(0.16)	0.87***	(0.15)
Herding (peer-alignment) bias	-4.92***	(0.16)	-5.97***	(0.24)	-4.02***	(0.21)
Experience of financial troubles	-0.58*	(0.31)	-0.47	(0.41)	-0.56	(0.49)
Interest in economic information	2.66***	(0.06)	3.00***	(0.08)	2.35***	(0.08)
Female dummy	-2.11***	(0.17)				
Government-employee dummy	3.64***	(0.40)	4.04***	(0.47)	3.30***	(0.81)
Student dummy	0.86*	(0.50)	1.34*	(0.69)	0.00	(0.74)
Education: compulsory only	-6.57***	(0.47)	-5.40***	(0.70)	-7.69***	(0.64)
Education: university or higher	6.51***	(0.17)	6.01***	(0.24)	7.26***	(0.25)
Asset holdings	5.28***	(0.13)	4.86***	(0.20)	5.79***	(0.18)
Mortgage Holding	2.66***	(0.06)	2.56***	(0.29)	2.80***	(0.28)
Year 2019 dummy	0.23	(0.20)	0.44	(0.28)	0.06	(0.27)
Year 2022 dummy	-2.01***	(0.19)	-2.19***	(0.27)	-1.69***	(0.26)
School \times Household education	-3.99***	(0.63)	-4.38***	(0.84)	-4.02***	(0.97)
Present-bias \times Asset holdings	-1.20***	(0.11)	-1.57***	(0.15)	-0.88***	(0.16)
Random-effects		SD		SD		SD
Intercept (age groups)		6.83		6.11		7.34
Slope for school education		2.61		2.84		2.08
Residual		21.65		22.02		21.17
N		79,545		39,290		40,255
R_m^2		0.33		0.35		0.29
R_c^2		0.39		0.40		0.37

Notes. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

proposed by Nakagawa and Schielzeth (2013) and the marginal coefficient of determination (R_m^2). The former incorporates both fixed and random effects, whereas the latter reflects fixed effects alone. In every specification, the R_c^2 exceeds the R_m^2 , indicating that accounting for random effects materially improves model fit.

Both formal financial education ($\beta = 4.98$; males = 3.47; females = 7.75) and household financial education ($\beta = 4.41$; 3.93; 4.86) are positive and significant, and the school effect is

substantially larger for females, consistent with Okamoto and Komamura (2021). The interaction term between school- and household-based education is negative and significant ($\beta = -3.99; -4.38; -4.02$), indicating sub-additive reinforcement rather than strict substitutability. In other words, individuals exposed to both channels achieve greater gains than either channel alone, yet smaller gains than the sum of the separate effects. This pattern reflects a partial overlap between educational content and learning mechanisms, implying that better coordination between formal and informal education can reduce redundancy and enhance overall learning efficiency.

For the remaining covariates, including behavioral biases, the signs are, unless otherwise noted, consistent with those of prior studies and standard theoretical priors: planning and asset holdings are positive; loss aversion and herding tendencies are negative; information access, higher education, and mortgage holding are positive; and compulsory-only education is negative. The small negative coefficient of household management is somewhat clear among males. The positive and significant coefficient on the mortgage variable ($\beta = 2.66; 2.56; 2.80$) may reflect a practical “learning-by-doing” effect, in which the experience of loan application, interest negotiation, and long-term repayment cultivates financial knowledge through direct engagement with financial institutions.

However, a notable exception arises in the present bias. This indicator has a positive and significant association with literacy ($\beta = 2.00; 3.17; 0.87$), contrary to the standard behavioral-finance prediction that stronger present bias should reduce financial competence. A plausible interpretation is that the item “prefer JPY 100,000 now rather than JPY 110,000 in one year” captures not only “irrational” present bias but also liquidity needs and time-preference considerations. To probe this mechanism, we include an interaction with asset holdings (Present-bias \times Asset), which is negative and significant ($\beta = -1.20; -1.57; -0.88$), indicating that the positive association of present bias with literacy diminishes as asset holdings increase and eventually vanishes or reverses. This pattern aligns with the liquidity constraint hypothesis, suggesting that an apparent positive association is primarily observed among respondents facing tighter liquidity constraints.

Model fit clearly improves when allowing for random components, as the two measures indicate: the marginal is 0.33 (males 0.35; females 0.29), while the conditional rises to 0.39 (0.40; 0.37). The random slope standard deviation for school-based education is sizable, indicating substantial heterogeneity in the effect of financial education across age groups.

To describe how financial literacy and the effect of formal financial education vary with age, Table 4 reports the random intercepts and slopes from the mixed-effects specification. The random intercepts represent age-group-specific deviations from the overall baseline score; they are negative at younger ages and positive at middle and older ages, indicating that after

Table 4. Random intercepts and slopes for Financial Literacy Scores

	Full Sample		Male		Female	
	Intercept	Slope	Intercept	Slope	Intercept	Slope
10s	-10.94	5.39	-9.37	5.25	-11.82	3.14
20s	-6.17	0.66	-6.31	0.20	-5.98	0.76
30s	-2.45	-1.19	-1.95	-2.19	-3.04	0.43
40s	1.23	-1.78	1.59	-2.95	0.72	0.16
50s	4.92	-1.24	4.03	-0.76	5.67	-0.62
60s	6.76	-1.27	5.55	-0.03	7.72	-2.02
70 +	6.64	-0.57	6.47	0.47	6.73	-1.85

controlling for covariates, baseline literacy levels increase over the life cycle. Similarly, the random slopes represent deviations from the average education effect, and the total effect (fixed effect plus random slope) remains positive across all age groups.¹² The estimates show that the marginal effect of formal financial education is most pronounced among adolescents and individuals in their early twenties, but declines monotonically thereafter, becoming smaller, though still positive, in midlife. This age-dependent attenuation is consistent with the “learning decay” mechanism discussed in educational psychology (Ebbinghaus, 1885; Anderson, 2010) and with empirical evidence from international studies showing that education-induced gains diminish over time (Kaiser & Menkhoff, 2017, 2020; Kaiser et al., 2022). The result also echoes the theoretical premise that once accumulated, educational capital depreciates in the absence of reinforcement or experiential learning (Becker, 1964; Bransford & Schwartz, 1999).

Compared with prior studies focusing on short-term intervention effects (e.g., Frisanchio, 2022; Agasisti et al., 2022), our results extend the evidence by documenting a clear long-term attenuation of formal education effects in Japan. The observed pattern further aligns with Okamoto and Komamura (2021), who identify an inverted-U relationship between age and financial literacy, but add that the marginal contribution of formal education diminishes substantially beyond the thirties, although the total effect remains positive across all age groups. This finding suggests that financial knowledge gained in adolescence retains value but becomes less decisive as individuals accumulate life experiences and rely more heavily on informal or experiential learning.

Importantly, the attenuation differs substantially by gender. Among males, the education-related slope declines sharply after the twenties and converges toward zero in later life, whereas among females, it remains positive and comparatively stable across age groups. This pattern corroborates the findings of Kaiser and Menkhoff (2017) and Haag and Brahm (2025) that financial education may equalize women, enhance knowledge retention, and mitigate gender

disparities in financial capabilities. Together, these results provide robust empirical evidence that while formal education can substantially elevate financial literacy in youth, its effects are transient without subsequent reinforcement, underscoring the importance of lifelong financial learning and re-education initiatives.

For complementary validation, we re-estimate the model by restricting the dependent variable to the *knowledge-based financial literacy score*, where the effects of formal education are expected to appear most directly. Table 5 presents the mixed-effects estimation results for this knowledge component expressed on a 100-point scale for direct comparability with the comprehensive literacy index. The estimated coefficients largely mirror those of the overall model, confirming that a substantial proportion of the effect of financial education occurs through the accumulation of factual financial knowledge. Formal financial education ($\beta = 5.94$; males = 4.10; females = 9.41) remains a strong and highly significant determinant, while household financial education ($\beta = 2.77$; 2.36; 3.17) has a weaker and more modest influence. The interaction between the two is negative but smaller in magnitude than that in the comprehensive model, suggesting a limited overlap between formal and informal learning in the domain of cognitive knowledge. These findings imply that household financial education primarily facilitates practical and attitudinal learning, whereas formal financial education programs reinforce the cognitive foundation of financial literacy.

Behavioral and attitudinal covariates such as planning, herding, and present bias maintain their expected signs, although their magnitudes are slightly attenuated relative to the overall model. This indicates that the stronger coefficients previously observed partly reflect the behavioral reinforcement channels through which knowledge is translated into practice. The negative interaction between present bias and asset holdings remains robust, reaffirming the liquidity constraint interpretation that time preference effects are moderated among wealthier respondents.

A pronounced gender disparity is also evident: the female dummy ($\beta = -9.35$) indicates a considerably larger gap in knowledge than in the comprehensive literacy measure ($\beta = -2.11$). Nonetheless, the formal education effect is more pronounced among females, suggesting that formal financial education compensates and narrowing gender gaps in knowledge acquisition. This pattern accords with international evidence (Lusardi & Mitchell, 2014; Kaiser & Menkhoff, 2017; Haag & Brahm, 2025) that financial education enhances women's cognitive financial competence and mitigates knowledge-based disparities.

Overall, these results demonstrate that formal financial education, typically delivered through schools or equivalent institutions, primarily strengthens the cognitive core of financial literacy, while behavioral and attitudinal components, more closely associated with informal learning, contribute a complementary layer of variation. The persistent knowledge effects, combined with

Table 5. Mixed-effects model results for the Financial Knowledge Score

Variable	Full		Male		Female	
	β	SE	β	SE	β	SE
Fixed-effects						
Intercept	35.79***	(3.09)	33.88***	(2.65)	27.85***	(3.49)
Formal financial education	5.94***	(0.61)	4.10***	(0.65)	9.41***	(0.88)
Household financial education	2.77***	(0.24)	2.36***	(0.38)	3.17***	(0.32)
Need for financial education	12.58***	(0.20)	13.74***	(0.28)	11.16***	(0.28)
Factor 1: Planning	4.26***	(0.12)	4.95***	(0.18)	3.55***	(0.17)
Factor 2: Household management	-0.80***	(0.12)	-0.88***	(0.18)	-0.71***	(0.17)
Loss-aversion tendency	-8.79***	(0.22)	-8.58***	(0.29)	-8.55***	(0.36)
Present-bias (myopic) behavior	0.73***	(0.13)	1.74***	(0.19)	-0.26	(0.17)
Herding (peer-alignment) bias	-3.34***	(0.18)	-4.31***	(0.27)	-2.52***	(0.24)
Experience of financial troubles	-0.25	(0.36)	-0.17	(0.47)	-0.2	(0.56)
Interest in economic information	3.34***	(0.06)	3.80***	(0.10)	2.93***	(0.09)
Female dummy	-9.35***	(0.19)				
Government-employee dummy	3.68***	(0.46)	3.47***	(0.54)	4.19***	(0.93)
Student dummy	2.24***	(0.57)	2.00**	(0.78)	2.01**	(0.84)
Education: compulsory only	-6.39***	(0.54)	-5.81***	(0.80)	-6.95***	(0.73)
Education: university or higher	7.61***	(0.19)	7.62***	(0.27)	7.94***	(0.28)
Asset holdings	6.31***	(0.15)	5.86***	(0.23)	6.79***	(0.21)
Mortgage Holding	1.60***	(0.23)	1.98***	(0.32)	1.27***	(0.32)
Year 2019 dummy	0.42*	(0.22)	0.83***	(0.32)	0.08	(0.31)
Year 2022 dummy	-1.32***	(0.21)	-1.42***	(0.31)	-1.10***	(0.30)
School \times Household education	-2.43***	(0.71)	-2.89***	(0.95)	-2.97***	(1.10)
Present-bias \times Asset holdings	-0.87***	(0.12)	-1.14***	(0.17)	-0.61***	(0.18)
Random-effects	SD		SD		SD	
Intercept (age groups)	8.1		6.86		9.13	
Slope for school education	1.04		0.78		1.18	
Residual	24.71		25.08		24.23	
N	79,545		39,290		40,255	
R_m^2	0.31		0.31		0.23	
R_c^2	0.37		0.35		0.33	

Notes. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

pronounced gender-specific responsiveness to formal education, underscores the importance of sustained, inclusive financial learning initiatives across the life cycle.

By contrast, when we restrict the dependent variable to financial knowledge, the cognitive component of literacy, the age-related pattern becomes even more pronounced. As Table 6 shows, the random intercepts are markedly negative among the young and rise monotonically across age groups, indicating that baseline financial knowledge continues to accumulate through

Table 6. Random intercepts and slopes for the Financial Knowledge Score

	Full Sample		Male		Female	
	Intercept	Slope	Intercept	Slope	Intercept	Slope
10 s	-11.59	1.28	-9.79	0.99	-12.91	0.57
20 s	-7.47	0.77	-6.82	0.56	-7.90	0.76
30 s	-4.22	-0.29	-3.28	-0.09	-5.15	0.29
40 s	0.36	-0.35	0.95	-0.42	-0.32	0.51
50 s	5.07	0.00	4.22	-0.08	5.90	-0.23
60 s	8.42	-0.97	6.71	-0.45	9.86	-1.24
70 +	9.42	-0.44	8.01	-0.50	10.53	-0.67

experience over the life cycle. The random slopes, which represent deviations from the average education effect, are positive in adolescence but decline with age, becoming negligible or slightly negative among those in their fifties and beyond. Nevertheless, the total effect (fixed effect plus random slope) remains positive across all age groups. Compared with the comprehensive literacy model, this pattern suggests that knowledge acquisition initially depends heavily on formal education, but is gradually supplemented by experiential and self-directed learning as individuals age.

Gender differences emerge again, although less starkly than in the comprehensive literacy model. For males, the slope turns slightly negative after their twenties but remains close to zero through later ages, suggesting that the cognitive benefits of early formal education largely persist, rather than rapidly dissipating, over the life cycle. For females, the slope remained positive throughout their forties before declining in later life. Notably, the random slope variance is substantially smaller for the knowledge-based measure ($SD = 1.04$ for the full sample) than for overall literacy ($SD = 2.61$), indicating that the effect of education on core financial knowledge is more stable across age groups. Thus, whereas overall financial literacy reflects both cognitive and behavioral dimensions, the knowledge-based measure isolates the cognitive trajectory. Knowledge stocks grow with age, and the marginal contribution of formal education, while attenuating, remains comparatively stable, underscoring the fact that the cognitive foundation established through early education retains its lasting value.

5. Conclusion

This study investigates how formal and household financial education jointly shape financial literacy across the life cycle in Japan by explicitly accounting for age-dependent heterogeneity through a linear mixed-effects framework. The results demonstrate that formal financial education exerts its strongest positive effect in adolescence and early adulthood, but that its

marginal impact diminishes with age, which is consistent with the learning-decay mechanism documented in educational psychology.

The supplementary analysis focusing on knowledge-based literacy further clarifies that formal education primarily strengthens the cognitive foundation of financial literacy. Additionally, this cognitive benefit remains comparatively stable across age groups relative to the broader literacy measure. While financial knowledge continues to accumulate naturally through experience over the life cycle, the foundation established through early formal education retains its lasting value. Moreover, the negative interaction between formal and household education indicates sub-additive reinforcement rather than strict substitutability; individuals exposed to both channels achieve greater gains than those exposed to either channel alone, yet smaller than the sum of the separate effects. This pattern reflects a partial overlap in educational content, suggesting that home-based instruction reinforces rather than duplicates the conceptual understanding acquired through formal schooling. Accordingly, the two forms of education function in a partially overlapping yet complementary manner. Formal schooling provides structured conceptual knowledge, whereas informal learning consolidates and contextualizes it through daily experiences. Improved coordination between these channels may therefore enhance reinforcement and strengthen long-term knowledge retention.

Gender differences remain pronounced. Women start from lower baseline levels of financial literacy yet benefit more from formal education, and these benefits tend to persist longer across their life course. This pattern suggests that financial education functions as an equalizing mechanism that mitigates gender disparities in financial capabilities. Allowing education effects to vary across age groups substantially improves the model fit, confirming that temporal heterogeneity is crucial for disentangling life-cycle progression from cohort differences in financial literacy.

Overall, financial education yields the largest benefits for youth. While the cognitive knowledge acquired through early formal education retains lasting value, the broader components of financial literacy, encompassing behavioral and attitudinal dimensions, tend to attenuate over time without reinforcement. Our findings have several policy implications. Given the attenuation of education effects with age, workplace-based financial education programs may serve as important vehicles for reinforcement learning in adulthood (Bernheim & Garrett, 2003). The strong gender heterogeneity documented in this study also suggests that inclusive programs that address women's needs may help reduce persistent literacy gaps. Sustained efforts to combine structured formal instruction with lifelong informal learning are essential for maintaining financial competence throughout adulthood.

Nevertheless, this study has several limitations. First, the survey measures formal financial

education using a single item that combines schooling, university education, and workplace training, precluding the separate identification of educational effects by institutional setting. Although we interpret this variable as capturing education received primarily in the early career stages, given the limited prevalence of systematic school-based financial education in Japan prior to 2022 and the concentration of workplace training in early employment, future research using more granular measures would strengthen causal identification. Second, the repeated cross-sectional nature of the data does not allow us to distinguish true learning decay from cohort differences in the quality or content of financial education. Panel data tracking individuals over time are needed to establish the temporal dynamics of the effects of education more definitively.

Despite these limitations, this study provides robust evidence that the effectiveness of financial education is age and gender dependent. These findings underscore the importance of designing adaptive, inclusive, and lifelong financial education strategies that reinforce early learning while responding to individuals' evolving financial needs throughout their life course.

NOTES

1. Further information on the questionnaire is available on the J-FLEC website (<https://www.shiruporuto.jp/e/survey/>).
2. The survey yielded 25,000 valid responses in both 2016 and 2019, and 30,000 responses in 2022.
3. This measure is an index that measures the suitability of data for factor analysis and evaluates whether factor analysis can be conducted appropriately due to low multicollinearity of the data (Kaiser & Rice, 1974). A KMO value below 0.60 is generally considered insufficient for conducting factor analysis.
4. To check robustness, we also extract factors using maximum-likelihood and minimum-residual (MINRES) methods; the resulting loadings were virtually identical and left the substantive findings unchanged.
5. Retaining or excluding these observations had no material impact on our results. We likewise drop cases in which all responses equal 1; we find only one such record (from 2016), and its exclusion did not alter the estimates, so we keep it in the final sample.
6. The seven items correspond to the following survey questions: Q18 and Q19 (compound interest), Q20 (inflation and purchasing power), Q21-2 (mortgage repayment), Q21-4 (risk diversification), Q22 (bond prices and interest rates), and Q31 (rule of 72). In the regression analyses, we normalize the raw score (28 maximum) to a 100-point scale for comparability with the comprehensive Financial Literacy Score.

7. The survey question for formal financial education asks: “Did you have an opportunity to receive ‘financial education’ such as classes on life planning and household budget management at schools, universities, or workplaces you attended?” A value of 1 denotes “I had the opportunity to receive the instruction and did so,” whereas 0 captures all other responses. For household financial education, the question asks: “Did you have an opportunity to learn about ‘money management’ from your guardians at home?” A value of 1 indicates “There was an opportunity to learn,” and 0 otherwise.
8. We code asset holdings 0 for respondents reporting “less than 2.5 million yen” or “don’t know,” 1 for “2.5 million yen to less than 10 million yen,” and 2 for “10 million yen or more.” Omitting this variable from the regression specification did not materially affect the results.
9. Such models are often called hierarchical or multilevel models. Hereafter, we adopt the latter, more widely used term.
10. Standard maximum-likelihood (ML) estimation jointly optimizes the fixed effects and variance components, leading to biased estimates of the latter. We therefore estimate the model via REML, which yields less biased variance-component estimates. For the likelihood-ratio tests used in model comparison, however, we revert to ML, because REML log-likelihoods are not comparable across specifications with differing fixed-effect structures.
11. In the subsequent section, we re-estimate the model separately for the male and female subsamples. In both strata, the likelihood-ratio test again rejects the null hypothesis, favoring the specification that includes random slopes.
12. The total education effect for each age group equals the fixed effect (β) plus the random slope (b_j). For example, using the full-sample estimates from Tables 3 and 4, $10s = 4.98 + 5.39 = 10.37$; $30s = 4.98 + (-1.19) = 3.79$; $50s = 4.98 + (-1.24) = 3.74$.

References

- Agasisti, T., Cannistrà, M., Soncin, M., & Marazzina, D. (2022). Financial Education during COVID-19—Assessing the effectiveness of an online programme in a high school. *Applied Economics*, 54(35), 4006–4029. doi:10.1080/00036846.2021.2016586
- Anderson, J. R. (2010). *Cognitive psychology and its implications* (7th ed.). New York: Worth Publishers.
- Becker, G. S. (1964). *Human capital: A theoretical and empirical analysis, with special reference to education*. Chicago: University of Chicago Press.

- Bernheim, B. D., & Garrett, D. M. (2003). The effects of financial education in the workplace: Evidence from a survey of households. *Journal of Public Economics*, 87(7–8), 1487–1519. doi:10.1016/S0047-2727(01)00184-0
- Bransford, J. D., & Schwartz, D. L. (1999). Rethinking transfer: A simple proposal with multiple implications. *Review of Research in Education*, 24(1), 61–100. doi:10.3102/0091732X024001061
- Central Council for Financial Services Information (2016). Financial literacy survey. *Results*. Retrieved from <https://www.shiruporuto.jp/e/survey/kinyulite/pdf/16kinyulite.pdf>
- Central Council for Financial Services Information (2019). Financial literacy survey. *Results*. Retrieved from <https://www.shiruporuto.jp/e/survey/kinyulite/pdf/19kinyulite.pdf>
- Central Council for Financial Services Information (2022). Financial literacy survey. *Results*. Retrieved from <https://www.shiruporuto.jp/e/survey/kinyulite/pdf/22kinyulite.pdf>
- Ebbinghaus, H. (1885). *Über das Gedächtnis*. Leipzig, Germany: Duncker & Humblot. (English translation: *Memory: A contribution to experimental psychology*. 1913).
- Fernandes, D., Lynch, J. G., Jr., & Netemeyer, R. G. (2014). Financial literacy, financial education, and downstream financial behaviors. *Management Science*, 60(8), 1861–1883. doi:10.1287/mnsc.2013.1849
- Frisancho, V. (2022). Is school-based financial education effective? Immediate and long-lasting impacts on high school students. *The Economic Journal*, 133(651), 1147–1180. doi:10.1093/ej/ueac084
- Haag, L., & Brahm, T. (2025). The gender gap in economic and financial literacy: A review and research agenda. *International Journal of Consumer Studies*, 49(2), Article e70031. doi:10.1111/ijcs.70031
- Kadoya, Y., & Khan, M. S. R. (2020a). Financial literacy in Japan: New evidence using financial knowledge, behavior, and attitude. *Sustainability*, 12(9), 3683. doi:10.3390/su12093683
- Kadoya, Y., & Khan, M. S. R. (2020b). What determines financial literacy in Japan? *Journal of Pension Economics and Finance*, 19(3), 353–371. doi:10.1017/S1474747218000379
- Kaiser, H. F., & Rice, J. (1974). Little jiffy, Mark Iv. *Educational and Psychological Measurement*, 34(1), 111–117. doi:10.1177/001316447403400115
- Kaiser, T., Lusardi, A., Menkhoff, L., & Urban, C. (2022). Financial education affects financial knowledge and downstream behaviors. *Journal of Financial Economics*, 145(2), 255–272. doi:10.1016/j.jfineco.2021.09.022
- Kaiser, T., & Menkhoff, L. (2017). Does financial education impact financial literacy and financial behavior, and if so, when? *The World Bank Economic Review*, 31(3), 611–630. doi:10.1093/wber/lhx018

- Kaiser, T., & Menkhoff, L. (2020). Financial education in schools: A meta-analysis of experimental studies. *Economics of Education Review*, 78, Article 101930. doi:10.1016/j.econedurev.2019.101930
- Lusardi, A., & Mitchell, O. S. (2011). Financial literacy around the world: An overview. *Journal of Pension Economics and Finance*, 10(4), 497–508. doi:10.1017/S1474747211000448
- Lusardi, A., & Mitchell, O. S. (2014). The economic importance of financial literacy: Theory and evidence. *Journal of Economic Literature*, 52(1), 5–44. doi:10.1257/jel.52.1.5
- Nakagawa, S., & Schielzeth, H. (2013). A general and simple method for obtaining R² from generalized linear mixed-effects models. *Methods in Ecology and Evolution*, 4(2), 133–142. doi:10.1111/j.2041-210x.2012.00261.x
- Okamoto, S., & Komamura, K. (2021). Age, gender, and financial literacy in Japan. *PLOS One*, 16(11), Article e0259393. doi:10.1371/journal.pone.0259393
- Organization for Economic Co-operation and Development (2015). *National strategies for financial education: OECD/INFE policy handbook*. Paris: OECD Publishing.
- Yamori, N., & Ueyama, H. (2017). Effects of financial education experience at school on financial literacy and financial behavior: Based on the 2016 Survey on Financial Literacy and Financial Troubles. *Studies in Financial Planning*, 17, 52–71. (in Japanese).
- Yoshino, N., Morgan, P., & Trinh, L. (2017). *Financial literacy in Japan: Determinants and Impacts* [ADBI working paper], 796.