



## Research article

## Financial knowledge of pre-university students: Effects of age and gender

Daniel Ruiz-Palomo<sup>a</sup>, M. Teresa Galache-Laza<sup>a,\*</sup>, Ana José Cisneros-Ruiz<sup>a</sup>, Francisca García-Lopera<sup>b</sup><sup>a</sup> Department of Finance and Accounting, University of Malaga, Spain<sup>b</sup> Department of Applied Economics (Mathematics), University of Malaga, Spain

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## ABSTRACT

Financial education is a constant social concern since it is essential to improve the well-being of individuals and society in general. Wrong financial decisions can have serious consequences that lead to serious economic and even social problems. Therefore, an adequate financial base is necessary and must be instilled from an early age. This work aims to identify the potential effects of two demographic variables, age and gender, on acquiring financial knowledge, delving into the potential moderating interrelationships between them. Applying a set of multi-level (mixed-effects) regression models to a sample of 9917 pre-university students from 175 high schools in Andalusia, our results show that: age and gender are significantly related to the acquisition of financial knowledge of pre-university students. Moreover, gender plays a moderating role in the relationship between age and the acquisition of financial knowledge of pre-university students. This study has practical implications for teachers, students, heads of educational centres and those responsible for educational plans because this paper's results help to better understand the key factors of financial education at a pre-college stage as it identifies significant differences in both age and gender. Policymakers responsible for educational plans are provided with the necessary evidence to propose adapting specific actions to the different student profiles. By doing so, they may design measures to make citizens' financial inclusion possible, resulting in greater welfare for society.

## 1. Introduction

Financial education is a constant social concern since it is essential to improve the standard of living of individuals and society, leading to greater financial well-being [1,2]. Poor financial education can bring serious consequences, such as over-indebtedness, lack of savings or inefficiency in managing personal finances, leading to severe economic and even social problems.

Things like doing simple price calculations when shopping, making transfers, using ATMs,<sup>1</sup> checking exchange rates, keeping track of interest rates, tracking income and expenses, managing bank accounts, prioritizing expenses, saving for hard times, using credit

*Abbreviations:* CTT, Classical Test Theory; IRT, Item Response Theory; KMO, Kaiser Meyer Olkin Test.

\* Corresponding author.

*E-mail addresses:* [drp@uma.es](mailto:drp@uma.es) (D. Ruiz-Palomo), [mtgalache@uma.es](mailto:mtgalache@uma.es) (M.T. Galache-Laza), [ajcisneros@uma.es](mailto:ajcisneros@uma.es) (A.J. Cisneros-Ruiz), [fg\\_lopera@uma.es](mailto:fg_lopera@uma.es) (F. García-Lopera).

<sup>1</sup> Automated Teller Machines.

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cards responsibly, managing a monthly budget, being aware of different alternatives when using money; are basic needs for everyone.

Factors influencing financial knowledge and behaviour include socio-economic status, educational attainment, cultural and societal norms, access to financial resources, and personal attitudes and beliefs. By understanding these factors, financial educators can create targeted financial education programs that consider individuals' specific circumstances and help them develop the required skills and knowledge to make informed financial decisions [3]. Therefore, based on the human capital theory, which is grounded on the resource-based view theory [4,5], adequate financial knowledge is needed to achieve a well-being status.

Many studies have consistently found that socio-economic variables such as gender, age, income, and employment status are closely related to financial knowledge [6,7].

In this sense, various studies show that age is a variable significantly related to financial knowledge in the general population, with the young segment, together with the elderly, suffering from the worst levels of financial education [8,9]. In addition, it is observed that the foundations of financial knowledge are built during childhood [10–12]. So, it seems interesting that young people receive financial education from an early age [13]; in this way, they can improve their financial skills in the future [14].

However, each stage of child/adolescent development requires instruction in a specific area of financial education. Thus, for primary school students, financial socialization is essential. As such, it means acquiring and developing values, attitudes, standards, norms and behaviours that provide contexts for one's financial practices [11]. On the other hand, adolescents and young adults aim to develop financial skills and habits. In short, financial education taught from an early age will support learning for later levels of training [15].

Likewise, studying gender differences is a constant in the educational and social spheres. In the field of financial education, a certain number of international investigations find a notable gender gap in financial knowledge: women have lower levels of financial knowledge compared to men [16,17], but the explanations for this gap remain a subject of active debate [18]. Some studies point out that education and experience can significantly influence men's and women's financial literacy [19]. In this regard, it should be noted that parents can play an important role as agents of financial socialization. Regarding high school students, a study carried out with data from 18 countries shows that there is a gender gap in financial knowledge that favours male students, so it seems plausible that parents can influence such knowledge [20]. Note that parental attitudes about gender roles may influence the decisions they make about teaching males and females about finances [21], facilitating the emergence of gender stereotypes in the students' preferences [22], which would explain a lower interest of women in acquiring financial knowledge in the pre-university stage. In addition, recent work suggests that women are less confident in their financial abilities than men [18], which might widen the gender gap as age increases and gender stereotypes become more widely accepted.

Consequently, the relationship between financial knowledge, age, and gender have been investigated extensively in the academic literature over the past ten years. Most of the research shows that financial knowledge tends to increase with age and that women tend to have lower levels of financial knowledge, even after controlling for demographic and other socio-economic factors [3,23,24]. Nevertheless, previous literature is inconclusive as some studies report that gender is not a significant predictor of students' level of financial knowledge [14,25,26]. Furthermore, to the best of our information, previous literature has not investigated the potential moderating role of gender in the relationship between age and the acquisition of financial knowledge.

Therefore, this study aims to evaluate the impact of gender and age on financial knowledge, assessing the moderating role of gender in the relationship between age and financial knowledge acquisition.

Hence, we have conducted our study on a sample of 9917 pre-university students from 175 high schools in Andalusia (Spain). We have chosen Andalusia because it is one of the least developed regions in the European Union. The GDP per capita of this area is less than 75% of the European average, occupying the 196th position of the 242 regions that currently make up the twenty-seven countries of the European Union [27]. Likewise, the Andalusian economy is marked by structural unemployment much higher than the Spanish average. The Andalusian unemployment rate is 19.4% compared to 13.6% for Spain. Consequently, there is a need to improve young people's financial education in Andalusia, especially in less developed areas. Therefore, national financial education strategies are necessary to increase financial inclusion and, ultimately, to favour the area's economic development [28].

## 2. Data and methodology

### 2.1. Sample characteristics and variable selection

Data collection was conducted in October and November 2019 through the Edufinet project, training activities for young people led by Unicaja Bank, one of Andalusia's most important financial institutions. This project aims to bring the financial culture closer to citizens by acquiring the knowledge required to make their fundamental financial decisions with objective criteria consciously and informedly (Edufinet, 2018).

All procedures performed in this study were in accordance with the Committee of Publication Ethics (COPE) guidelines and the standards of the institutional ethical committee. Regarding data collection, informed consent was obtained from all the volunteer participants and their legal guardians when they were minors; no personal data were recorded, so the anonymity of the participants was ensured. Due to the nature of the activity, the absence of any physical or psychological damage is guaranteed.

Our sample of 9917 pre-university students from 175 high schools in Andalusia was obtained based on a designed questionnaire

that participants could complete after some financial sessions. Most of the participants in the project were aged between 12 and 21 years old and completed the survey voluntarily. The information was collected within a randomly selected sample of the high schools by members of the Edufinet team, other than the high school's staff, through a questionnaire<sup>2</sup> the students had to answer once the session ended. Our study has been carried out with the information obtained from the answers given by the students.

The questionnaire included four questions related to basic financial concepts such as inflation, simple and compound interest rate and risk diversification, in line with the questions in the Survey of Financial Competences prepared by the National Securities Market Commission and the Bank of Spain [29]. The survey also included questions on the respondent's socio-demographic characteristics and the evaluation of the session, which must be completed after the session. These variables were coded as seen in Table 3.

A summary of the sample characteristics regarding the educational centre can be seen in Table 1, and the province, gender and age range in Table 2. Table 3 shows the definition of the variables.

Finally, the acquisition of financial literacy was assessed by aggregating four questions related to four basic financial concepts: inflation, simple interest, compound interest and investment risk.

## 2.2. Methodology

We used Stata 14 software (Stata corp.) in all our analyses as follows:

Firstly, we checked that the four items were normally distributed by applying Ferguson's Delta index to evaluate the applicability of the Classical Test Theory (CTT).

Secondly, factor analysis was performed using iterations from the tetrachoric correlations to check whether all the questions measure the same dimension of financial knowledge or not to identify the usefulness of Item Response Theory (IRT).

Thirdly, we analyzed the proportion of correct answers for each variable and their correlations; we then estimated the ability of the questions to distinguish between individuals by applying Loevinger's H index.

Item scores were then estimated according to the one- and two-logistic IRT.

We then adopted a multi-level regression approach, called mixed-effects or hierarchical [30,31], to avoid potential problems of estimation bias derived from classical methods because the values of the school variables of students from the same school are correlated [32]. The procedure was as follows: we coded the students' correct answers as 1, 0 otherwise. Next, the probability of success was regressed with the explanatory variables age, gender, and the control variables described above. Next, a variable was created that encodes the number of correct answers in the exam, taking integer values from 0 to 4, and it was standardized. Further, we conducted a model in which the intercept and the age effect were distinguished by gender to identify its potential moderating effect on the relationship between correct answers and the respondent's age. In addition, we checked the significance of the gender differences regarding intercepts and age slopes through the Wald Chi2 test. This process was repeated to identify which variables affect the number of correct answers in the exam, taking a multi-level linear regression model of mixed-effects (mixed) and for each response individually, using a logistic mixed-effects model (melogit).

Mixed effects models are characterized by containing both fixed effects and random effects. In linear models, fixed effects are analogous to standard regression coefficients and are estimated directly. Random effects are not estimated but summarized according to their estimated variances and covariances. Random effects can take the form of random intercepts or random coefficients. In matrix notation,

$$y = X\beta + Zu + \epsilon \tag{1}$$

Where  $y$  is the  $n \times 1$  vector of responses,  $X$  is an  $n \times p$  design/covariate matrix for the fixed effects  $\beta$ , and  $Z$  is the  $n \times q$  design/covariate matrix for the random effects  $u$ . While  $X\beta$  represents the fixed portion of equation [1], the random portion of [1] is  $Zu + \epsilon$ . Then, our model can be indistinctly written as in Eqs. (2) or (3).

$$\text{Right Answers}_{ij} = \beta_0 + \beta_1 \text{age}_{ij} + \beta_2 \text{gender}_{ij} + \beta_3 \text{age}_{ij} \cdot \text{gender}_{ij} + \dots + \beta_s \text{CVs}_{ij} + u_{0j} + u_{sj} \text{CVs}_{ij} + \epsilon_{ij} \tag{2}$$

$$\text{Right Answers}_{ij} = \beta_0 \cdot 0.\text{gender} + \beta_1 \cdot 1.\text{gender}_{ij} + \beta_2 \cdot 0.\text{gender}_{ij} \cdot \text{age}_{ij} + \beta_3 \cdot 1.\text{gender}_{ij} \cdot \text{age}_{ij} + \beta_s \text{CVs}_{ij} + u_{0j} + u_{sj} \text{CVs}_{ij} + \epsilon_{ij} \tag{3}$$

Where  $\text{CVs}_{ij}$  represent the control variables described in Table 3 (Previous studies, Self-perceived previous knowledge, Rating and Amusing presentation).

Similarly, a set of binary logistic regression models with mixed effects (melogit) were tested to identify which variables influence the success of the responses on each question. Melogit models fit mixed effects models for binary and binomial responses that assume that the random effects of the answers follow a Bernoulli conditional distribution, whose probability of success is determined by the cumulative logistic distribution function. To do this, melogit performs optimization using the original variance component metric. In this sense, our models can be described as Eqs. [4] or [5] indistinctly.

$$\text{Logit}[\text{Pr}(Y_{ij} = 1)] = \beta_0 + \beta_1 \text{age}_{ij} + \beta_2 \text{gender}_{ij} + \beta_3 \text{age}_{ij} \cdot \text{gender}_{ij} + \dots + \beta_s \text{CVs}_{ij} + u_{0j} + u_{sj} \text{CVs}_{ij} + \epsilon_{ij} \tag{4}$$

$$\text{Logit}[\text{Pr}(Y_{ij} = 1)] = \beta_0 \cdot 0.\text{gender} + \beta_1 \cdot 1.\text{gender}_{ij} + \beta_2 \cdot 0.\text{gender}_{ij} \cdot \text{age}_{ij} + \beta_3 \cdot 1.\text{gender}_{ij} \cdot \text{age}_{ij} + \beta_s \text{CVs}_{ij} + u_{0j} + u_{sj} \text{CVs}_{ij} + \epsilon_{ij} \tag{5}$$

<sup>2</sup> The EDUFINET project certifies that the data obtained in the framework of its *XI Jornadas de Educación Financiera* have been subject to internal control in terms of the methodology used, data collection and analysis, in the bodies of the aforementioned project.

**Table 1**  
Multi-group characteristics of the sample.

Number of centres	Number of observations per training centre			
	Minimum	Average	Maximum	Number of observations
175	7	55.5	218	9917

**Table 2**  
Demographic characteristics of the sample.

	Gender			Age				Total
	Male	Female	DK/DA	Up to 15	16 or 17	18 or 19	20 or more	
Almería	367	461	7	149	569	62	55	835
Cádiz	467	532	18	173	571	146	127	1017
Córdoba	363	427	16	142	546	53	65	806
Granada	791	877	44	336	1094	173	109	1712
Huelva	98	108	4	62	124	23	1	210
Jaén	411	509	12	140	530	117	145	932
Málaga	1216	1373	81	648	1476	293	253	2670
Sevilla	780	932	23	425	1034	166	110	1735
Total	4493	5219	205	2075	5944	1033	865	9917

**Table 3**  
Questionnaire and variables definition.

Variable	Questionnaire verbatim	Values
<i>Financial knowledge [29]</i>		
Inflation	Five siblings receive a gift of €1000, which they share equally. If they must wait a year to get their share of the €1000 and that year's inflation is expected to be 1%, when they receive the money they will be able to buy: a) More than they could buy today b) The same c) Less	1: correct 0: incorrect or not answered
Simple Interest	You deposit 100 euros in a savings account with a fixed interest rate of 2% per annum. This account does not generate any fees or taxes. If you do not make any other deposits into this account or withdraw any money, how much money will be in the account at the end of the first year once the interest is paid to you?	1: correct 0: incorrect or not answered
Compound Interest	Based on the assumption in the previous question, if you do not make any deposits or withdraw any money, how much money will be in the account after five years? - More than 110 euros - Exactly 110 euros - Less than 110 euros	1: correct 0: incorrect or not answered
Investment Risk	It is generally possible to reduce the risk of investing in the stock market by buying a wide variety of shares.	1: correct 0: incorrect or not answered
Number of right answers	Aggregation of previous answers. Number of correct answers	0 to 4
<i>Socio-demographic variables</i>		
Gender	Gender of the individual	1: female 0: male Missed: otherwise
Age	Age of the individual (number of years)	11 to 50
Previous studies	Do you study or have you studied economics?	1: yes 0: no
Self-perceived previous knowledge	What level of knowledge do you consider you have?	1: low 2: medium 3: high
Rating	How would you rate the training session? Students evaluate the course from 0 to 10. The evaluation is then recoded from 0 (D: Failed) to 3 (A: Outstanding).	0: D failed 1: C passed 2: B notable 3: A outstanding
Amusing presentation	Did you enjoy the presentation?	1: yes 0: no

Finally, we adopted some cautions regarding the potential endogeneity of the model despite not having instrumental variables. First, we used the Hausman test to verify that the proposed models are consistent and efficient compared to those that only consider fixed effects and/or against those that only consider random intercepts. Second, we incorporated a higher moment variable ( $age^3$ ) into

the model, verifying that, although it is significant, its inclusion does not change the coefficients of the rest of the variables. Third, we added gaussian copulas to our model with similar results, so endogeneity is not considered a major problem. However, the absence of instrumental variables can be a limitation, and further research should explore this issue.

### 3. Results

Fig. 1 analyses the percentage of correct answers to knowledge questions disaggregated by gender. It shows that the question on compound interest was much more difficult for both groups and that gender differences are more pronounced on the simple interest rate question. We evaluated the validity of the test questions according to the two dominant theories of the tests, the classical and the item response theories. In this sense, Ferguson’s Delta index obtained a value of 0.909, very close to 0.90, the index’s value representing the normality of its distribution. This value allows us to interpret the results using the Classical Test Theory (CTT).

Additionally, factor analysis only modelled composites with Eigen values less than one, and the uniqueness of the variables ranged between 0.67 and 0.98, with alpha and KMO indices less than 0.70, namely 0.12 and 0.47, respectively. These results suggest that the questions measure different dimensions of financial knowledge, limiting their interpretability based on IRT by violating one of its basic assumptions. Moreover, All tetrachoric correlations were less than 30%, showing differences among individual responses. Furthermore, only the first two Loevingher H indexes were significant; all were less than 0.3. Table 4 and Table 5 summarize the results obtained in our preliminary tests.

Applying the one-logistic IRT method, it appears that the most challenging question was the one on compound interest, and the easiest was the one on inflation. Moreover, there seem to be significant differences in the difficulty of the questions. Concerning the two-logistic IRT method, it can be inferred that the ability to discriminate between individuals is very significant in the questions on simple interest rates and inflation, significant in the question on compound interest rates, and weak in the question on risk. However, these findings should be interpreted with caution due to the result of our preliminary analyses.

Items analyses are concluded in Fig. 2 with graphical analyses of their characteristic curves (panel A) and their information functions (panel B). The question regarding compound interest was much more difficult for the students, and this question has very different values from the rest of the questions in the test.

Table 6 summarizes the results as described in section 2.2.

First, the intercept for men is significantly higher than women’s except for the compound interest, suggesting that men are more likely to be correct than women regarding inflation, simple interest and investment risk questions. Similarly, they will obtain more correct answers on the test. In short, women have lower levels of financial literacy, as reported in the previous literature [33].

Secondly, in line with Okamoto & Komamura [34], our results suggest that age positively and significantly affects the probability of success in almost all questions and the total number of correct answers in the test for both men and women. So, we can conclude that some of the knowledge students acquired could be due to their own life experience, except in the investment risk question. It could be that students generally have no prior investment experience, which means that all their investment risk knowledge comes from educational activities rather than previous life experience [35]. The relationship between age and the probability of getting a correct

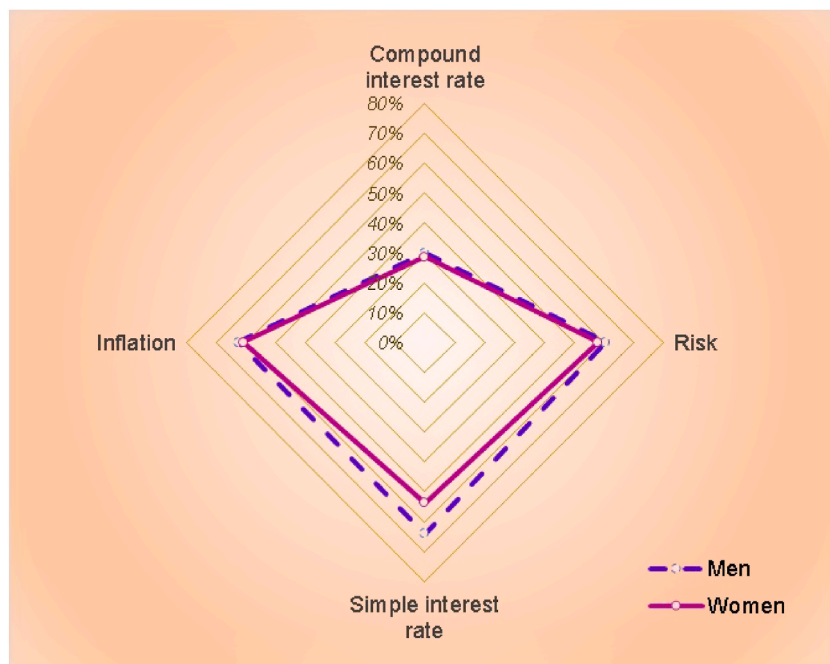


Fig. 1. Correct answer rates.

**Table 4**  
Items analysis (I).

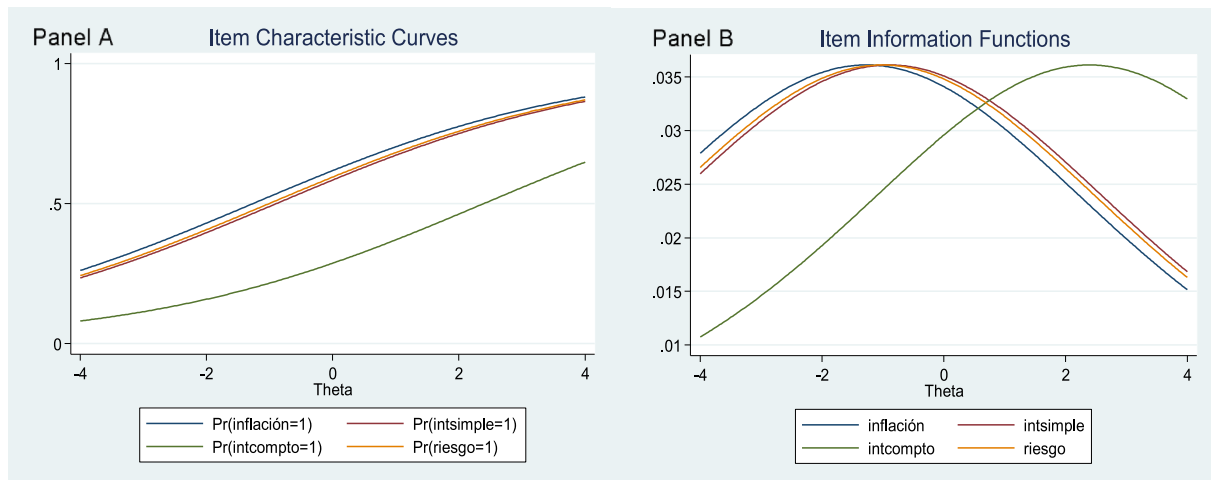
		Correct	TetrachoricCorr.				Loevingher Test		
		Answers (%)	I	II	III	IV	H	z	p
I	Inflation	61.4%	1				0.09	12.45	***
II	Simple interest	58.1%	0.26	1			0.06	8.42	***
III	Compound interest	29.3%	0.06	-0.06	1		-0.01	-0.68	0.75
IV	Risk	59.2%	0.02	0.03	-0.02	1	0.01	1.21	0.11
	Set							7.67	***

\*\*\*:  $p < 0.01$ .

**Table 5**  
Items analysis (II).

	IRT 1 pl		IRT 2 pl		Dif.	z
	Dif.	z	Discrim.	z		
Inflation	-1.26	-12.20***	0.62	8.69***	-0.82	-9.26***
Simple interest	-0.89	-10.80***	1.75	5.94***	-0.29	-10.40***
Compound interest	2.39	13.63***	-0.08	-2.20**	-10.49	-2.21**
Risk	-1.00	-11.30***	0.07	1.91*	-5.63	-1.90*
Set	0.38	13.60***				

\*:  $p < 0.1$ . \*\*:  $p < 0.05$ ; \*\*\*:  $p < 0.01$ .



**Fig. 2.** Characteristic curves and item information functions.

answer to the compound interest question in the female group was not significant either. It could be that, unlike men, female students in these courses do not have much life experience with compound interest rates.

Third, the Wald test for age coefficients of men and women was significant in all the models, except for investment risk. It is also observed that the effect of age on the probability of getting the first three questions right and on the total number of correct answers is significantly higher in men. It, therefore, suggests that gender moderates the effect of age on the probability of success in the first three questions (Fig. 3 panel A) and on the total number of correct answers (Fig. 3 panel B) in the test, as shown in Fig. 3. Although many studies prove the existence of a gender gap in pre-university students' financial literacy [36,37], our work is one of the first to confirm that gender moderates the influence of age on financial knowledge levels.

Specifically, males are more likely to get the inflation question right (0.63\*\*\* vs. 0.53\*\*\*), with statistically significant differences (Wald: 4.72\*\*). Age also affects this probability in both men (0.28\*\*\*) and women (0.07\*), although it is the male group where the effect is more relevant, with very significant differences (Wald: 13.37\*\*\*).

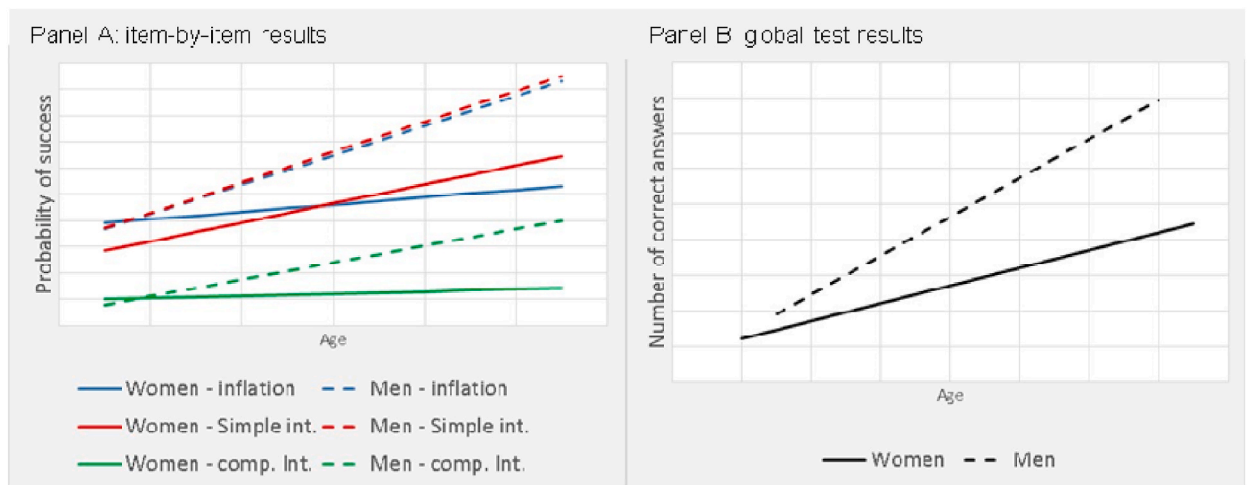
Gender effect on the probability of getting the simple interest question right is even stronger (0.65\*\*\* for men vs. 0.11\*\*\* for women, Wald: 120.10\*\*\*). However, the gender difference in the effect of age on this probability is, although weakly significant, much smaller than in the previous case (0.29\*\*\* for men vs. 0.18\*\*\* for women, Wald: 2.76\*).

Regarding the question on compound interest, it is observed that there are no significant gender differences (-0.94\*\*\* for males vs. -0.97\*\*\* for females, Wald: 0.41). Still, these differences are significant in terms of the effect of age on the probability of success in

**Table 6**  
Regressions results.

	Inflation	Simple Int.	Compound Int.	Risk	Right Answers
<b>Intercept</b>					
Male	0.63 [8.49]***	0.65 [7.86]***	-0.94 [-15.64]***	0.47 [8.85]***	0.09 [2.82]**
Female	0.53 [7.23]***	0.11 [1.32]	-0.97 [-16.57]***	0.38 [7.23]***	-0.06 [-2.07]*
Wald test	4.72**	120.10***	0.41 (n.s.)	4.73**	60.15***
<b>Slope</b>					
Age (male)	0.28 [5.32]***	0.29 [4.95]***	0.16 [3.95]***	-0.08 [-1.90]	0.11 [6.17]***
Age (female)	0.07 [2.10]*	0.18 [4.57]***	0.02 [0.51]	0.02 [0.52]	0.05 [4.08]***
Wald test	13.37***	2.76*	9.07***	-	6.82***
<b>Control variables (respondent level)</b>					
Amusing presentation	0.07 [2.18]*	0.09 [2.23]*	0.04 [1.17]	0.01 [0.32]	0.04 [2.83]**
Self-perceived level	0.11 [3.39]***	0.08 [2.28]*	0.03 [0.73]	0.06 [1.78]	0.05 [3.48]***
Course evaluation	0.03 [0.83]	0.09 [2.46]*	0.00 [-0.04]	0.04 [1.21]	0.03 [2.23]*
Previous studies	0.14 [3.41]***	0.16 [3.51]***	0.00 [-0.01]	0.06 [1.77]	0.07 [4.83]***
<b>Random effects:</b>					
Constant	0.68 [6.75]***	0.88 [7.13]***	0.35 [6.08]***	0.27 [5.98]***	-2.22 [-14.93]***
Amusing presentation	0.04 [2.34]*	0.10 [3.20]**	0.03 [1.75]	0.04 [2.55]*	-2.00 [-18.14]***
Self-perceived level	0.05 [3.05]**	0.10 [3.86]***	0.10 [4.00]***	0.06 [3.48]***	-2.40 [-12.60]***
Course evaluation	0.06 [2.98]**	0.07 [3.09]**	0.08 [3.10]**	0.05 [2.84]**	-2.27 [-14.18]***
Previous Studies	0.10 [3.42]***	0.11 [3.62]***	0.04 [2.32]*	0.03 [2.25]*	-1.06 [-16.14]***
Error					-0.11 [-14.25]***
Conditional Intra Class Correlation					0.13 [8.70]***
Wald Chi2					159.28***

[t-statistic in brackets]. \*: p < 0.1; \*\*: p < 0.05; \*\*\*: p < 0.01.



**Fig. 3.** Moderation effects.

each of the two groups (Wald: 9.07\*\*\*). Specifically, age affects positively and significantly in the male group (0.16\*\*) and is not significant in the female group (0.02).

Unlike in the previous case, the question on investment risk shows that there are significant gender differences, so men (0.47\*\*\*)



are more likely to be successful than women (0.38\*\*) (Wald: 4.73\*\*). However, the effect of age is not significant for either gender ( $-0.08$  for men and  $0.02$  for women). It suggests that age is irrelevant to answering this question correctly.

Finally, the total number of correct questions in the test is significantly higher in the male group (0.09\*\*) than in the female group ( $-0.06^*$ ) (Wald: 60.15\*\*\*). Moreover, age is a much more relevant variable for men (0.11\*\*\*) than for women (0.05\*\*\*) for the number of correct answers in the test (Wald: 6.82\*\*\*).

Concerning the control variables, it is observed that all of them significantly predict the total number of correct questions in the test. Nevertheless, analyzing the probability of correct answers for each question individually, it is observed that the control variables affect the questions on inflation and simple interest but not the questions corresponding to compound interest and risk.

Specifically, in the first place, having shown interest in the training activity has a positive effect on passing the test (0.04\*\*) because more correct answers are given to the questions on inflation (0.07\*) and simple interest (0.09\*), but not to the questions on compound interest and risk.

Secondly, and similarly, the level of previous knowledge of the training activity reported by participants significantly affects the number of correct answers (0.05\*\*\*) and the probability of correct answers on the inflation (0.1\*\*\*) and simple interest (0.08\*) questions, but not on the rest of the questions. Consequently, the student's self-perception of financial knowledge does not seem to affect the more complex concepts but only the simpler topics.

Thirdly, the training action evaluation by the students who have taken it does not seem to significantly affect the probability of success in any of the specific questions. Nevertheless, there is a weak significance in the simple interest question (0.09\*) and the total number of correct answers (0.03\*). It could be viewed as spurious because it is relevant for only one question and has a low significance.

Finally, having studied economics before the training course is very relevant both for the probability of correct answers to the question on inflation (0.14\*\*\*) and simple interest (0.16\*\*\*) and for the total number of correct answers in the test (0.07\*\*\*), in line with what might be logical. However, such studies do not seem to have trained the student in complex concepts such as compound interest rates and investment risk.

#### 4. Conclusions

This work aimed to identify the potential effects of age and gender on acquiring financial knowledge, identifying the interactions among these variables to explore a potential moderating role of gender. To do that, we applied a set of multi-level (mixed-effects) logit and linear regression models to a sample of 9917 pre-university students from 175 high schools in Andalusia. Our results suggest that age and gender are relevant demographic characteristics in acquiring financial knowledge, revealing a significant interaction effect between gender and age. These results contribute to a better understanding of the critical factors of financial education at a pre-college stage as it identifies significant differences in gender and age. Likewise, these findings evidence that there are also significant differences in the understanding of financial knowledge between men and women based on age, which indicates the existence of a gender impact: age has a more significant influence on the results obtained in the tests conducted by male students rather than by female students. For example, age is more significant in the understanding of the effects of inflation in men than in women; similarly, there are more differences between men and women in the understanding of compound interest at older ages than younger ages (see Table 6). These conclusions align with previous studies [3,38] and ratify that there are still important differences in the education of men and women and/or the influence exercised by parents [19]. By analyzing the relationship between age, gender, and financial knowledge, the study provides new insights into how these demographic factors may influence individuals' financial knowledge.

Based on the human capital theory [39,40], our study demonstrates that women obtain worse results in financial training, that age positively influences the acquisition of financial knowledge, and that this effect is greater in men than in women, causing a moderating effect on the relationship between age and financial knowledge. Parental attitudes about gender roles could facilitate the emergence of gender stereotypes that could condition students' preferences [22], explaining women's lower interest in acquiring financial knowledge [38].

Therefore, following our results, practical implications exist for teachers, students, heads of educational centres, and those responsible for educational plans. First of all, teachers will be able to identify the guidelines that facilitate the understanding of financial knowledge and adapt their [teaching practices](#) to the needs of each group. Secondly, students can take the appropriate measures to facilitate knowledge acquisition and confidently make their own financial decisions. Thirdly, the directors of educational centres will be able to adapt the specific activities to develop financial knowledge, both in curricular and extra-curricular activities, to the student profile. Finally, policymakers responsible for educational plans are provided with the necessary evidence to propose adapting specific actions to the different student profiles. Our study also underscores the need to include key socializing agents like parents in education strategies to improve financial knowledge.

Our research has its own set of limitations that should be explored in future research. Firstly, the geographical scope was limited to Andalusia. However, we hope that the findings are similar to other regions and even to other countries. It may be interesting to replicate our model in different geographical areas of Spain and even in databases from various countries, which offers new possibilities for future research. Likewise, the study could be extended to university and post-graduate financial education. Moreover, the sample selection was not random, as it was obtained from the student population that undertook the training activity, and data collection was cross-sectional. So no information is available on the evolution of financial knowledge students acquire throughout their educational stage. In turn, it could be analyzed whether the effect of pre-university financial education on well-being is sustained not only in young adults but throughout the different stages of life and whether this effect is the same for men and women. Finally, further research should explore potential endogeneity issues regarding this model.



## Production notes

### Author contribution statement

Daniel Ruiz-Palomo: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

M. Teresa Galache-Laza: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Ana José Cisneros-Ruiz: Contributed reagents, materials, analysis tools or data; Wrote the paper.

Francisca García-Lopera: Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

### Data availability statement

The authors do not have permission to share data.

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## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Additional information

No additional information is available for this paper.

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