**The impact of an online game-based financial education course:
Multi-country experimental evidence**

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Financial literacy and the importance of its evaluation

- **Financial literacy** represents an important asset to make conscious decisions in everyday life (Remund, 2010).

- Despite its importance, many individuals worldwide have **low levels of financial literacy** (De Beckker, 2019). This is particularly prevalent among young people, as evidenced by evaluations of 15-year-olds in the PISA assessment (OECD, 2014; 2017; 2020).

     Financial Education

- **Evaluating the impact** is crucial to understand whether and how different initiatives have the desired impact on participants (Kaiser & Menkhoff, 2017; Kaiser & Menkhoff, 2020; Kaiser et al., 2022).

- **By understanding the learning mechanism and features of successful interventions,** financial education can become a useful tool to improve financial literacy (Collins and Odders-White, 2015).

When designing interventions in the financial education domain, **recent trends in teaching and evaluation** are worth considering.

- There is a growing emphasis on **gamification**, which assumes that incorporating learning-by-playing aspects enhances interest and motivation among students (Dicheva et al. 2015).

- In an educational context, a game-based approach involves implementing **real-world activities** (Kiili, 2007).

→ Given its practical applicability, **the adoption of innovative learning-by-playing initiatives in financial education appears to be an effective strategy** for conveying financial concepts (Batty et al., 2020).

→ However, the **evidence regarding its effectiveness remains limited** (Angel 2018; French et al. 2020; Kalmi and Rahko, 2022; Rodriguez-Raga and Martinez-Camelo 2022; Sconti 2022).

Research Goal:

This study investigates the effectiveness of a game-based activity, namely a *Financial Escape Room*, to enhance the financial literacy levels of secondary school students.

- **Treatment**: simple and concise online game; storytelling is the main feature of this activity
- **Method:** RCT experiment with 2587 students in 109 schools
- **Data**: Sample from four countries (Belgium, Estonia, Italy and Slovakia)
  - The evaluation across countries is unique and may be considered an asset for testing whether the initiative is scalable across different contexts
- **Results**: Impact of the treatment on student's financial literacy: 1.166 SD
  - Variation among countries: Belgium: 1.171 SD; Estonia: 1.146 SD; Italy: 0.084 SD; Slovakia: 0.043 SD

Evaluation of financial education activities for students

Authors & year	Place	Students involved	Treatment	Main findings
Bruhn et al. (2016)	Brazil	25.000 Secondary school students	Financial education activity	Students register **significant improvements in financial proficiency** but mixed evidence for financial behaviour.
Bover et al. (2018)	Spain	3,000 9th grade students	10-hours financial education course	**Largest improvements** have occurred for **students from disadvantaged socio-economic background.**
Frisancho (2020)	Peru	high-school students	National financial education program	The evaluation reports learning gains in the treatment group that **helped reduce initial inequalities**.
Iterbeke et al. (2020)	Belgium	2,407 students from 8th and 9th grades	Differentiated instruction of the financial education programme	Findings indicate that **while differentiated treatments do not influence financial knowledge for the entire sample, non-native students benefitted significantly**.

Summary: The available evidence suggests that educational programs improve students' financial literacy, with a specific positive effect on those from socioeconomically disadvantaged backgrounds.

Evaluation of online financial education interventions

Authors & year	Place	Students involved	Treatment	Main findings
Angel (2018)	Austria	296 students between 16- to 22- year-olds	a documentary movie on debt, an internet exercise and a budgeting smartphone app	Using a budgeting app increase frequency of current account check-up No effect of web research exercise and movie screening on financial knowledge and interest in financial topics.
Batty et al. (2020)	USA	1805 elementary school students	a simulation-based activity on engaging elementary school students in making daily financial decisions	Significant and robust improvements in financial knowledge, comparable to those achieved through traditional frontal lectures on the same topics.
Rodriguez-Raga and Martinez-Camelo (2022)	Colombia	1337 students from 6 to 18 years	Game, guide, and website	While no significant differential effects are observed among treatments, there is an overall improvement in financial literacy levels.

Game-based approach to Education

- **Gamification has emerged a promising alternative**
  - Through gameplay, students practice skills and develop valuable attitudes to their intellectual, social and emotional growth (Dicheva et al. 2015).
  - One particularly appealing aspect of games is the inclusion of challenging problems along with scaffolding techniques that guide players towards finding solutions (Deater-Deckard et al., 2013; Sweetser and Wyeth, 2005).

- **Digital games have recently become important teaching and learning tools** (Klopfer et al. 2009; De Grove et al. 2012; Deater-Deckard et al. 2013).

- Given that **financial literacy instruction emphasizes problem-solving in real-life contexts**, digital games offer a logical choice for developing the necessary skills in students (Koh, 2016)

Evaluations of game-based approach to Financial Education

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The effects of game-based financial education: New survey evidence from lower-secondary school students in Finland

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Digital vs. in-person financial education: What works best for Generation Z? ☆

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- Both studies find no significant differences when comparing the impact of game-based and traditional teaching methods
  - Game-based instruction is as effective as the conventional approach in terms of acquired financial knowledge.
  - Games and simulation activities can be a valuable tool to improve financial literacy of young students.

1. **Most most of the experiments conducted in this domain involve teachers as mediators** of knowledge transmission, with two consequences:

   i.   they need to train teachers on financial topics, resulting in an upfront and substantial investment cost

   ii.   variations in the quality of teachers, potentially affecting the effectiveness of the intervention

   → This research explores the treatment effects of a fully digital initiative where **no teacher intermediation** is required

2. **Existing studies usually refer to initiatives conducted in a single country**

   → This research is in a **multi-country setting** involving students from **four (European) countries**. This allows for the exploration of heterogeneity effects across different educational systems.

Financial literacy in Estonia, Belgium (Flanders), Italy and Slovenia

	Year	PISA position (and score)	Source of heterogeneity:		
			Gender	Socio Economic Status	Immigrant status
Estonia	2012	3rd place (529 pt.)	Females perform slightly better than males on average (+1 pt. vs.)	SES shows far below-average link with scores (6.7%)	Immigrant students score above-average link with scores -(+20%)
	2015	Not participating in this wave			
	2018	1st place (547 pt.)	Males perform slightly better than males on average (+3 pt.)	SES shows far below-average link with scores (6.1%)	Non-immigrant students perform better than immigrant ones on average (+33%)
Belgium (Flanders)	2012	2nd place (541 pt.)	Males obtain 11 pt. more than females on average (but not statistically significant).	SES shows a below-average link with scores (11.3%)	Non-immigrant students perform better than immigrant ones on average (+8%)
	2015	2nd place (541 pt.)	Males and females obtain comparable scores on average.	SES shows above-average link with scores (16.0%)	Non-immigrant students perform better than immigrant ones on average (+75.4%)
	2018	Not participating in this wave			
Italy	2012	17th place (466 pt.)	Males obtain 8 pt. more than females on average.	SES shows below-average link with scores (7.5%)	Immigrant students score below-average link with scores (+2%)
	2015	9th place (483 pt.)	Males obtain 11 pt. more than females on average.	SES shows below-average link with scores (5.5%)	Non-immigrant students perform better than immigrant ones on average (+18.2%)
	2018	13th place (476 pt.)	Males obtain 15 pt. more than females on average.	SES shows below-average link with scores (7.9%)	Immigrant students score below-average link with scores (17.4%)
Slovakia	2012	16th place (470 pt.)	Females perform slightly better than males on average (+3 pt.)	SES shows above-average link with scores (18.2%)	Data not available
	2015	12th place (445 pt.)	Females perform far better than males on average (+25 pt.)	SES shows below-average link with scores (6.5%)	Data not available
	2018	12th place (481 pt.)	Males and females obtain comparable scores on average.	SES shows above-average link with scores (15.2%)	Data not available

Note: Data are taken from OECD reports of PISA financial literacy of 2012, 2015 and 2018. The source of heterogeneity are calculated as follows:
Gender: difference in mean scores between males and females. Statistically significant difference are highlighted in bold. OECD average are 1 (2012), -5.5 (2015) and 2.4 (2018).
SES: Percentage of explained variance in financial literacy performance due to socio-economic status. OECD average are 13.7% (2012), 9.9% (2015) and 10.2% (2018)
Immigrant status: Score-point difference between students with no immigrant background and students with an immigrant background (after accounting for socio-economic status). OECD average are 6 (2012), 26.1 (2015) and 21.7 (2018). Statistically significant difference are highlighted in bold. Only country with a percentage of immigrant students higher than 5% are shown.

The *Financial Escape Room* is an interactive online game. It presents students with a series of challenges that they must overcome to access a bank vault.

The game is divided in **three parts**:

1. In the first part, students need to answer **18 questions** correctly **about payment methods** in order to obtain a *morse* code which grants them entry to the bank.

2. Once inside, students must search for the employee who knows the location of the vault. This is achieved through a 'Who is it?' game where students are presented with **10 calculations about interest or money change calculations**. Each correct calculation earns them a hint that helps them to find the employee with vault location knowledge.

3. In the final level, students encounter 10 multiple-choice questions covering topics such as **means of payment, bank accounts, interest rates, change calculation, and understanding of VAT or inflation.**
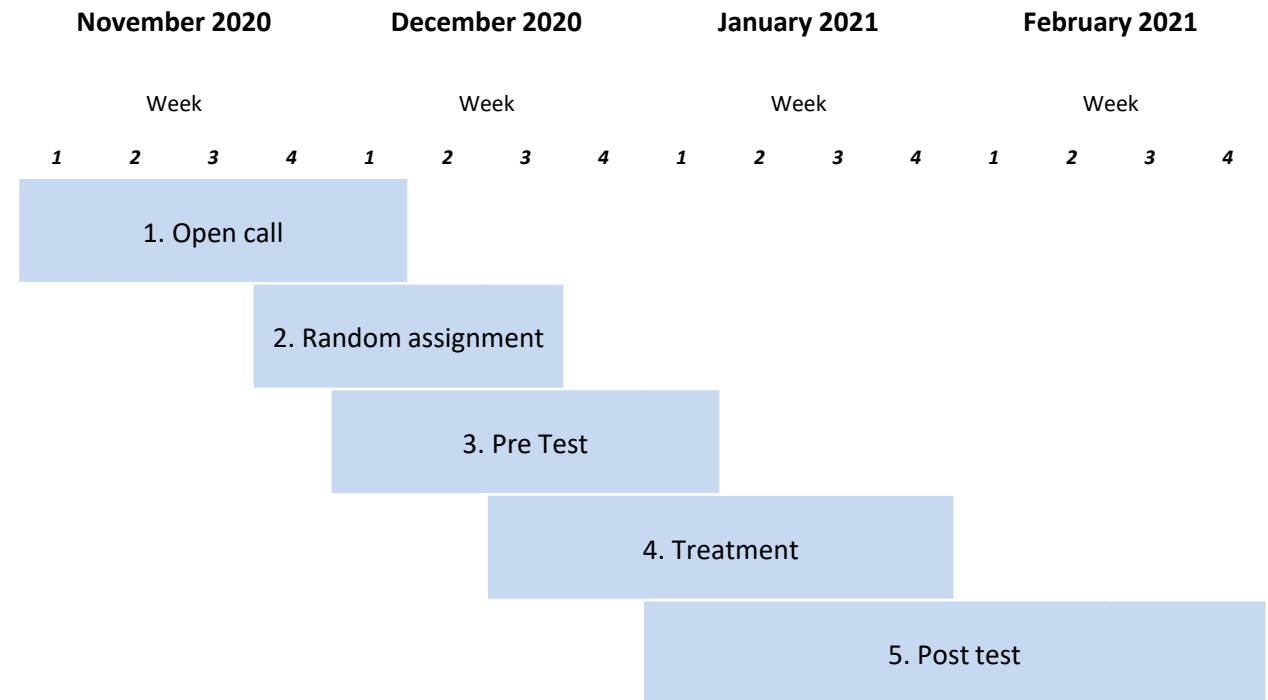
Throughout the game, students have the option to consult **information sheets** if they do not know the correct answer, allowing them to progress while learning.

https://toll-net.be/moodle/xertetoolkits/play.php?template_id=47544#page1

Experimental Design

Randomized Controlled Trial:

1. Open call
2. Randomization and assignment to control and treatment group
3. All: pre test to assess baseline financial knowledge and collect demographics information
4. Treatment group: Financial Escape Room (around 2 hours)
5. All: post test to assess financial knowledge

	November 2020	December 2020	January 2021	February 2021
	Week	Week	Week	Week
	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4

1. Open call

2. Random assignment

3. Pre Test

4. Treatment

5. Post test

Variable	Description	Type	Possible values
Gender	Whether the student is male	Binary	{0; 1}
Age	Students' age	Numerical (integer)	[11, 17]
Home language	Whether the student's language spoken at home is the national language	Binary	{0; 1}
Family	Number and age of student's siblings (if any)	Categorical	{only child; older siblings; younger siblings; older and younger siblings}
No Holidays abroad	Whether the students did not travel abroad with his/her family during 2019	Binary	{0; 1}
Math grade	Grade obtained in math in the previous year: from 1, the lowest level, to 4, the highest one	Numerical (integer)	{1; 2; 3; 4}
Literature grade	Grade obtained in literature in the previous year: from 1, the lowest level, to 4, the highest one	Numerical (integer)	{1; 2; 3; 4}
Academic school track	If the student is enrolled in an academic school track	Binary	{0; 1}
Country	The school's country	Categorical	{Estonia; Belgium; Italy; Slovakia}
PreTestScore	Total correct answers from the pre test	Numerical (Continuous)	[0, 1]
PostTestScore	Total correct answers from the post test	Numerical (Continuous)	[0, 1]

Descriptive Statistics

Variable	Control group (N = 1048)	Treatment group (N = 1539)	Total (N = 2587)	p.value
Gender				0.106
Men	41.2%	38.1%	39.3%	
Age				< 0.001
Mean (SD)	15.58 (1.495)	14.66 (1.929)	15.04 (1.820)	
Home language				0.647
Natives	93.2%	92.8%	92.9%	
Family situation				
1 - only child	175 (16.7%)	223 (14.6%)	398 (15.4%)	
2 - older siblings	342 (32.6%)	486 (31.7%)	828 (32.1%)	
3 - younger siblings	399 (38.1%)	581 (37.9%)	980 (38.0%)	
4 - older and younger siblings	132 (12.6%)	242 (15.8%)	374 (14.5%)	
No holidays abroad				< 0.001
Yes	32.3%	22.6%	26.4%	
Math grade				0.319
Mean (SD)	2.816 (0.886)	2.853 (0.964)	2.838 (0.933)	
Literature grade				0.113
Mean (SD)	2.906 (0.739)	2.957 (0.852)	2.936 (0.808)	

Variable	Control group	Treatment group	Total	p.value
Academic school track				< 0.001
yes	900 (85.9%)	1384 (90.3%)	2284 (88.5%)	
Country				< 0.001
Belgium	130 (12.4%)	516 (33.7%)	653 (25.0%)	
Estonia	250 (23.9%)	289 (18.9%)	539 (20.9%)	
Italy	531 (50.7%)	490 (32.0%)	1021 (39.6%)	
Slovakia	137 (13.1%)	237 (15.5%)	374 (14.5%)	
Pre test score				0.0012
Mean (SD)	0.615 (0.185)	0.591 (0.197)	0.601 (0.193)	
Post test score				< 0.001
Mean (SD)	0.532 (0.184)	0.556 (0.167)	0.546 (0.174)	

- Two methodological challenges:
  I. Tackling the imbalances in terms of observable characteristics
     - Inverse Probability of Treatment Weighting (IPTW) is proposed to improve the power of the Randomised Controlled Trial (RCT)
  II. Multi-country context
     - Different strategies are adopted: no country effects, fixed country effects, random country effects, and interaction effects.

IPTW imply two main steps (Chesnaye et al., 2022)

1. The <u>propensity score</u> is calculated.

    - The propensity score is defined as the conditional probability of being exposed to a particular treatment given the values of measured covariates, as it follows: $p(\boldsymbol{X}) = P(T = 1 | \boldsymbol{X})$

    - Where $p(\boldsymbol{X})$ represents the probability of being treated, given a set p of baseline covariates, represented as $\boldsymbol{X}=(X_1,\dots,X_p)$.

2. <u>Weights</u> are calculated as the inverse of the propensity score:

$$IPTW = w(\boldsymbol{X}) = \frac{1}{1 - p(\boldsymbol{X})}$$

Following the guidelines provided by Feaster et al. (2011), we follow four different statistical approaches:

1. No country effects

    *   Ignoring any country-specific influence

2. Fixed country effects

    *   Fixed effects for each country are adopted to account for within-country analysis of treatment effects

    *   The model is specified as follows:

$$y_{ij} = \alpha + \beta_{ij}Treatment_{ij} + \gamma_{ij}x_{ij} + \delta_j d_j + \varepsilon_{ij}, \sum_{i=1}^{S} \delta_j = 0 , e_{ij} \sim N(0, \sigma_e^2)$$

3. Random country effects

    *   Random effects account for variability in the outcome due to differences across countries

    *   The model specification is as follows:

$$y_{ij} = \alpha + \beta_{ij}Treatment_{ij} + \gamma_{ij}x_{ij} + s_j + \varepsilon_{ij}, s_j \sim N(0, \sigma_s^2), e_{ij} \sim N(0, \sigma_e^2)$$

Following the guidelines provided by Feaster et al. (2011), we follow four different statistical approaches:

4. Interaction effects

- The country-by treatment interaction via fixed-effect approach attempts to control for both the main effect of country and

    the country-by-treatment interaction but does not model the variability in these terms resulting from country differences.

- The model is expressed as follows:

$$y_{ij} = \alpha + \gamma_{ij}x_{ij} + \delta_j d_j + \rho_i d_j Treatment_{ij} + \varepsilon_{ij},$$

$$\sum_{j=1}^{S} \delta_j = 0, \sum_{j=1}^{S} \rho_j = 0, \ e_{ij} \sim N(0, \sigma_e^2),$$

Treatment effect

	Dependent variable: PostTest Score			
	No country effects	*Fixed effects*	*Random effects*	*Interaction effects*
	Model (1)	Model (2)	Model (3)	Model (4)
Treatment	0.163***	0.166***	0.170***	
	(0.006)	(0.006)	(0.006)	
Treatment [1] x country [Belgium]				0.171***
				(0.012)
Treatment [1] x country [Estonia]				0.146***
				(0.011)
Treatment [1] x country [Italy]				0.084***
				(0.009)
Treatment [1] x country [Slovakia]				0.043***
				(0.015)
Observations	2,587	2,587	2,587	2,587
R2	0.189	0.199		0.213
Adjusted R2	0.185	0.194		0.207

- Digital and gamified approach to financial education improves student's literacy scores by 0.166SD on average (in line with previous traditional approaches
- Main advantage of online game-based approaches over traditional class-based initiatives with teacher involvement
    - Scalability with limited financial costs
    - Reduction in terms of teacher training
- Intervention is effective across four countries
    - Heterogeneity in the effect size across countries might relate to cultural differences.
    - Previous research indicated that cultural differences have an impact on financial literacy beyond the socio-economic characteristics of individuals (De Beckker et al., 2020)
- Future research: effect of games on behaviour?
    - Role playing

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