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**Gamification to teach and assess financial education: A case study of self-directed
bank investors**

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Abstract

Financial education has become a popular research topic, due the growth of marketing financial services, and the wide range and complexity of investment products available online. To assess the investment risk, and decide what product is suitable for individuals, it becomes essential to use tools to improve financial education. An educational game may be a possible solution since is a serious game designed to teach adults about a specific subject and to teach them a skill. Games-based learning software are interactive play that helps to solve problems, teaches, and gives the fundamental needs of learning by providing – enjoyment and motivation. This study investigates the financial education of self-directed investors in complex financial products, and portfolio management to answer our research question – how well adult self-directed investors understand financial education about complex financial products and portfolio management – and evaluates the financial education level of self-directed bank investors in complex financial products with high risk.

An online quiz game with multiple-choice questions was developed, and deployed on a bank website to assess knowledge across investment product literacy - in addition to sociodemographic characteristics – involving the participation of 1,597 self-directed adult investors. The survey also enabled a comparison between the core and advanced skills of financial education knowledge. To measure and assess the financial education, we calculate the individual score by the amount of correct answers from the three multiple answer quiz questions. The results highlight that participants have a satisfactory overall financial literacy level. While core competencies, knowledge among private investors have a higher degree of general financial education, there are particular areas in which they scored low in advanced skills (i.e., complex financial product questions).

This result provides valuable insights, information for further investigation of distance education research through games, which can only continue to grow because of the increasing complexity and importance of financial education in modern societies. This study contributes to an understanding of adults' knowledge regarding investments in complex financial products, as well as providing a valuable contribution to ongoing financial education research.

Keywords: Gamification, Financial Education, e-banking, Quiz Game, self-directed adult investors.

1. Introduction

The current economic conditions have raised serious fears about private investors' financial security, particularly for those who lack the skills and resources to withstand financial market downturns and take advantage of upswings. Using the advantage of e-banking schemes, individuals are demanding responsibility for a rising number of financial decisions (OECD, 2013). Arguably, the two most important of these are purchase and investment planning. As these options are becoming more complex, questions are raised about individual financial well-being.

The recent financial crisis has brought to light the issues of making far-reaching decisions without enough knowledge and tools. With the expansion of e-banking, the financial markets around the globe have become more accessible to private investors, as well as offering new financial bank products and services that are ever more complex. Nonetheless, the asset price movements and the financial market volatility, cause of the recent financial crisis, challenge private investors to obtain more data, and to be better prepared to pursue investment decisions.

Despite what private investors might say or infer about the financial markets, and overseeing their finances, it is often beneficial to find help and more information about the complexity of products offered by banks (LaPlante & Paradi, 2015). Moreover, the shift from the traditional model of investment analysis and advisory assistance from a personal finance expert to self-analysis and investment requires better knowledge and information about the product and the underlying asset (Marsden *et al.*, 2011). First, individuals need to understand something about the mind-bending financial terminology used in the marketplace. Second, they need to understand what the product is (e.g. in terms of product features and risks). Ultimately, they need to have access to financial market information in order to follow the investment's performance. Thus, the dramatic shift from the traditional personal financial advisor to a participant-directed investment has increased the decision-making responsibility of private investors for their investment planning. With this change comes with growing evidence that private investors are making poor choices about the right products for their risk profile, especially in selecting from among the vast range of investment options.

In recent years, there has been interest and concern over the lack of financial education about banking products, mainly among private investors. Banks, policy makers, and other financial organizations are concerned to identify strategies for improving individual investors' well-being (OECD, 2013). Over the past few decades, these objectives have turned attention toward the financial capability of individuals. Private investors who make good financial decisions, and effectively interact with providers of financial services, are also more likely to achieve their financial goals, and thereby improve their financial condition. Similarly, improving individual investor financial education will lead to financial sector confidence, which in turn is strongly tied to economic growth. Financial capability is the internal capacity to act on one's best financial interest given social economic conditions. The overall concern, therefore, encompasses the knowledge,

attitudes, skills, and behaviors of private investors as they strive to understand, select, and make use of financial services that fit their needs.

Financial education requires that an individual knows and understands the forms, functions, and risks involved in the operation they are contemplating. In this sense, determining individuals' knowledge about investment products is first necessary in order to measure the financial education skill level of adult investors (Skills, 2014; Atkinson & Messy, 2012; Hastings et al., 2013). Assessing an adult's financial education amounts to measuring the degree to which she or he understands key financial concepts and possesses the ability and confidence to manage personal finances. Therefore, measures of financial education are essential to realize the adult's educational impact as well as the barriers to making an effective financial decision (Huston, 2010).

The present paper presents an exploratory study that analyzes the financial education of investors in complex financial products like mutual funds, in order to understand, essentially: How private investors' knowledge (financial education) may help them in their decisions regarding complex financial investments and portfolio management.

In this study, we evaluate the financial education of private bank investors through a quiz game that uses a questionnaire with multiple-choice questions. To do this, we challenged private investors to play a game developed to measure their financial knowledge. The questions in the game focus on complex financial product investments, whose terms, features, and risks are difficult to evaluate, and that are expected to be reasonably difficult to be understood by a private investor, due to the complexity of the investment's structure. The quiz game had seven scales assessing financial education pertaining to invest in complex financial products. There were two sets of questions, having different degrees of difficulty (basic skills: common sense financial knowledge; and advanced skills: advanced knowledge about investment in complex financial products and portfolio management). The game sought to assess individuals' knowledge regarding the topics covered, and at the same time, could actually help to improve their knowledge. In addition, our study explored investors' sociodemographic characteristics, according to gender, age, and education.

Quiz games are a simple and attractive means to provide workplace financial education (Lusardi & Mitchell, 2008; Mandell, 2009; Van Raaij, 2016). Hence, with an easy process to interpret, and gain knowledge, private investors should be more easily disposed to make their decisions on investments, having a good notion about the products and risks undertaken.

The 2008 financial crisis (and its aftermath) triggered demand for financial education programs around the globe, as well as a more comprehensive strategic plan of policies promoting wider access to financial products, increased awareness, and improved financial education (Hastings et al., 2013; Honkapohja, 2014). In addition, most individuals do not plan well, and fail to make effective decisions to manage their financial investments. As the worldwide financial crisis has demonstrated, this can cause a negative impact on financial and economic stability as well as on individuals' well-being, especially among private investors (OECD, 2013). Furthermore, most financial education

surveys conducted worldwide show that a majority of the population does not have sufficient knowledge to understand even basic financial products or the risks associated with those products (OECD, 2013). Though there is a substantial body of theoretical and empirical work on the economics of education, little research has been conducted on understanding adults' financial education level (Agnew & Harrison, 2015; Paluri & Mehra, 2016). The goal of this study is therefore to answer the following question: how well do adult private investors understand complex financial products and portfolio management?

Our contribution to the literature on financial education's effectiveness is threefold. First, our empirical evidence for adult self-directed investors using a Portuguese bank's online platform throws new light on the level of adult financial education regarding complex products. Second, our detailed analysis of pre-and post-test responses in relation to quiz game content provides valuable insights into what works for self-directed investors. Finally, this study contributes to an understanding of adults' knowledge about investments in complex financial products, as well as providing a valuable contribution to ongoing financial education research.

The paper proceeds as follows. Section 2 describes the literature review, Section 3 presents the method and data, and Section 4 outlines the main results. Section 5 then reports the results and discussion, after which Section 6 concludes along with limitations and suggestions for future research.

2. Literature Review

2.1. Financial Education or Literacy

Many researchers and organizations operating in different disciplines have financial literacy that is limited in a variety of ways (Huston, 2010; Hung et. al., 2009; Atkinson, et al., 2007). In 2008, the President's Advisory Council on Financial Literacy (PACFL) defined financial literacy as one's attitude to make use of individual awareness, abilities to effectively, and efficiently deal with individual financial resources, for a whole life span for the purpose of financial welfare (Schwab *et al.*, 2008). Financial literacy may be viewed as a combination of awareness, knowledge, skill, attitude, and behavior necessary to make sound financial decisions and ultimately achieve individual financial wellbeing (INFE, 2011). Financial literacy is the skill to make well-informed decisions regarding the application and management of financial investments and portfolio risk diversification (Lusardi & Mitchell, 2008). Consequently, financial literacy can also be considered as the understanding of underlying economic and monetary concepts along with the skills to use this understanding and information, and to handle financial resources effectively and efficiently.

Financial education helps one make better decisions regarding spending and saving, since it assumes knowing and understanding the forms, functions, and use of money and financial services. This is also important from the perspective of self-directed investors and banks (Johnson &

Sherraden, 2007). As today self-directed investors are living in a more complex financial environment than in the past, the need for financial education has increased enormously. Globalization makes it even more difficult to reach a correct conclusion on topics such as financial planning and asset management decision. In recent years financial education has attracted the interest of various groups, including governments, bankers, employers, community interest groups, financial markets, and other organizations, especially in developed countries. The importance of improving financial education has increased because of several factors, including the development of new financial products, the complexity of the financial markets, and changes in political, demographic, and economic variables.

2.2. Why Financial Education is Important

The importance of financial education has been gaining interest around the world over the past few years (Lusardi & Mitchell, 2011). The primary cause for this is that today we live in a highly complex environment, confronting many problems such as political instability and economic and financial distress. Globalization and the complexity of the financial markets have intensified the demand for financial literacy. Globalization also makes it harder for people to make suitable decisions regarding buying or selling investment products.

In the United Kingdom (UK) alone there are 13.1 million people classified as having low or no financial capability (Accenture & Loyds, 2016). These people will be less able to deal with unplanned financial events, and much less likely to achieve financial well-being. In fact, people everywhere need to adapt rapidly in our volatile society, and this reality has been contributing to ever greater product development and new investments. This also explains why governmental, regulatory, institutional, and financial organizations, corporate and professional investors, and individuals have an increasing need for financial literacy (OECD, 2013). The attention of governments is growing around the globe on the critical need to empower people through financial education.

As governments launch new enterprises and national strategies to improve the financial skills of the population, demand has grown for research to identify social subgroups with specific financial education needs, and to develop initiatives and instruments to improve their financial well-being (Atkinson & Messy, 2013). To address these demands, the OECD launched its financial education project in 2002, developing policy analysis and recommendations. Those recommendations were focused on the best practices and principles in financial education, and awareness, specifically in sectors such as credit, insurance, and self-directed investments in risk products, like as mutual funds, stocks, bonds, and others.

Financial education also helps individuals realize how to manage the income they have available, and the amount they can eventually invest or save. In financial behavior, it is likewise relevant to understand risk and fiscal issues (Pellinen *et al.*, 2011). Financial education is also

significant as it is joined with financial practices, such as cash-flow management, credit management, savings, and investment (Hilgert *et al.*, 2003). Because of financial illiteracy, self-directed investors frequently face fiscal troubles in the United States and in Europe. Self-directed investors are not sufficiently enlightened on how to make investment decisions (Norvilitis *et al.*, 2003; Todd, 2002). Van Rooij *et al.* (2011) or to determine that someone who is not financially knowledgeable is making poor investment decisions in the stock market. Individuals who lack financial knowledge may face adverse consequences of their financial decisions, are less likely to plan for retirement, and are more liable to end up with less wealth close to retirement (Lusardi & Mitchell, 2007).

Though there is a significant theoretical and empirical work developed on the economics of education, little attention has been given to how an individual acquires and deploys financial literacy (Glewwe, 2002; Hanushek & Woessmann, 2008). In recent years, few articles have examined the decision to acquire financial literacy or studied the links between financial knowledge, saving, and investment behavior (Jappelli & Padula, 2013; Lusardi *et al.*, 2013; Hsu, 2016).

In part, the lack of financial literacy explains the financial crisis that started in 2008 when Lehman Brothers filed for bankruptcy (e.g. James, 2009). Several other important factors also contributed to this situation, including lax interest rate policy, poorly aligned incentives in real estate mortgage markets, and the reluctance of investors to forgo seemingly safe returns in favor of high-yield mortgage-backed securities.

2.3. Financial Education Evaluation and Measures

Much of the financial education debate may be linked to the fact that a great deal of variation still exists in how researchers define and measure financial education itself (Hung *et al.*, 2009). In addition, considerable debate continues about the role of financial education, and only few studies have sought to measure financial education, partly because researchers lack the appropriate data (Van Rooij *et al.*, 2011). To evaluate financial education worldwide, and identify opportunities for improvement, Visa conducted a survey with five questions between February and April of 2012, with 25,500 participants in 28 countries (Barometer, 2012). Brazil topped the field, scoring 50.4 out of 100. Mexico, Australia, United States of America, and Canada rounded out the top five (Figure 1).

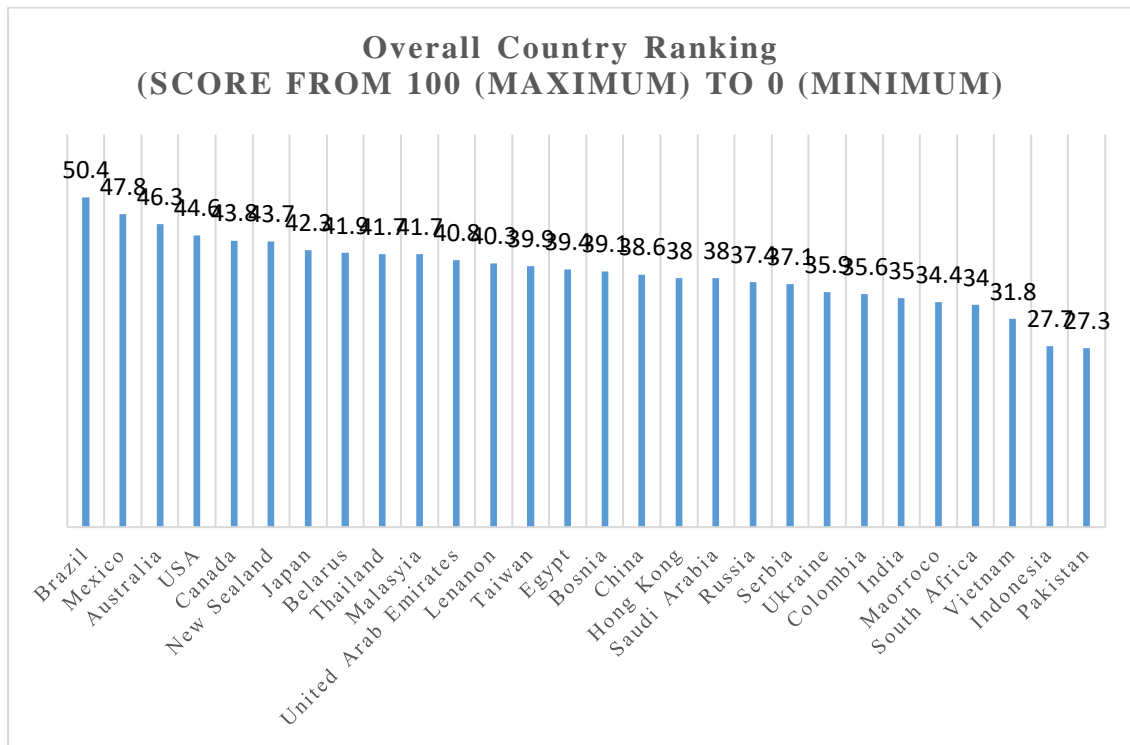


Figure 1. Overall Country Ranking (Most financially literate, left to right). (Source: Barometer, 2012).

Other financial education surveys, assessing risk assessment, were performed by Standard & Poor’s (Global FinLit Survey, 2015), and the conclusion is that just one-third of the world’s population is financially literate. These survey rankings were calculated by interviewing more than 150,000 randomly selected adults in more than 140 countries over the course of 2014. Adults surveyed had to answer just five multiple-choice questions. On a country-by-country basis, Norway, Denmark, and Sweden tied for first place, with a score of 71 ranking as financially literate. At the bottom of the spectrum was Yemen — in which a score of just 13 was deemed as financially literate by the S&P survey (Figure 2).

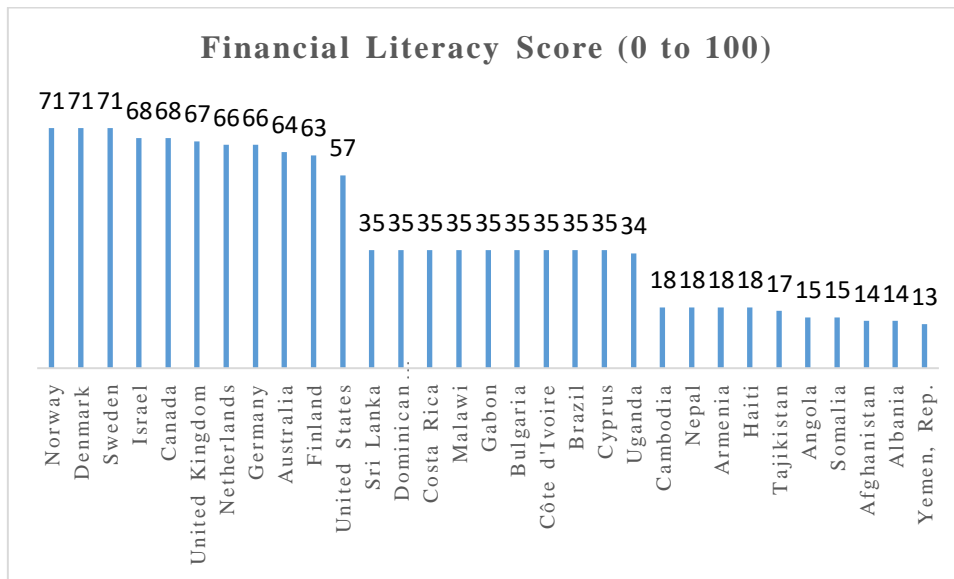


Figure 2. Global Financial Literacy Ranking of the 148 countries targeted in 2014. (Source: Global FinLit Survey, 2015).

Improving financial information and literacy is essential to support the individual decision-making procedure, depending on the resources available over time. Persons with a high level of financial literacy and capability help to raise the standard of market efficiency and required regulation. Consequently, financial literacy is increasingly important, as innovation and international economic integration widen the scope and complexity of financial services.

2.4. Problem of Bank Personal Investment Advisory

The self-directed investors of the e-banking generation face a new challenge: investing and managing their financial products. In the past, any self-directed investor requested help from financial advisors and trusted in their expertise to invest on her/his behalf. Today, self-directed investors have access to e-banking channels to obtain information and decide where and in what they should invest online. Participant-directed investment planning may increase individual autonomy, and thin out the potential that bank employees advise investment under funding. Professional advisers, who might be able to address potential errors, have been criticized for conflicts of interest that can expose investors to paying excessive fees and earning lower returns (Fisch & Wilkinson-Ryan, 2013; Freeman & Brown, 2000).

The crash of Enron in 2001 and Worldcom in 2002 brought ethical concerns to the head of public awareness. Their demise caused thousands of personal bankruptcies in which many customers lost all of their investments and savings, causing a wake-up call to regulators and financial organizations around the world. Even scrupulously honest financial advisors can now face real (and common) dilemmas when undertaking to perform the correct procedures for their customers. First, when financial advisors are also acting as sellers of financial products, the

investment advice maybe is biased (Bolton *et al.*, 2007; Inderst & Ottaviani, 2009; Stoughton *et al.*, 2011). Biased advice might not improve customers' portfolio allocations, and may even be detrimental (Bergstresser *et al.*, 2009; Shapira & Venezia, 2001). Second, self-directed investors might not demand advice. In addition, it has been concluded that the supply of fair financial investment advice is not sufficient to improve an investor's portfolio management and allocations (Bhattacharya *et al.*, 2012).

2.5. Games: a Powerful Teaching and Evaluation Tool

Serious games can be a powerful means to boost teaching, education, and knowledge evaluation tools (Guillén-Nieto & Aleson-Carbonell, 2012). The use of games in financial literacy education, as a tool, seeks to reduce the cognitive learning effort (Lee & Hammer, 2011). It is well known that a person often learns through gaming (e.g. Greitzer *et al.*, 2007), whether he is alone in executing a certain task, discovering how to play online games (or others), or teaching a range of subjects, including financial literacy (e.g. Kriz, 2003).

Computer games can be a persuasive teaching tool (Paraskeva *et al.*, 2010). Games are a very popular activity with a variety of audiences, and can be used to motivate people and teach strategy (Vos *et al.*, 2011). The use of games to engage people in playing and learning is potentially a way to address the lack of financial literacy (Gee, 2003). In addition, computer games meeting pedagogical criteria should become an integral piece of learning (Divjak & Tomić, 2011). A web-based quiz game used as a formative assessment can enhance learning and motivation (Wang, 2008). Games in the form of a multiple-choice quiz software tool may enhance the social and emotional growth of personality (Hamari *et al.*, 2014). Through the game's characteristics (e.g. points, feedback, leaderboard, or challenge) individuals are motivated to play due to the enjoyment during the learning process (Cheong *et al.*, 2013).

In recent years, several organizations have been using games with the purpose informing, teaching, persuading, and influencing individuals, in order to improve their financial education (e.g. Braunstein & Welch, 2002; Figart, 2011), as summarized in the following examples:

- **TD Case - quiz game “Money Quiz for Parents!”:** The game provides children's money lessons independently of the child's age and developmental level. By understanding key concepts, such as having financial goals, saving, and surviving on a budget, young people can make good decisions today and gain experience for their subsequent lives.
- **Play Moolah:** A game based in technologies to engage and educate its target audience on financial education. The goal of Play Moolah is to encourage smart money decisions through a social enterprise game to struggle with poor financial education during the financial crisis started in 2008.

- **Financial Soccer:** Developed in partnership with FIFA, helps provide children and young adults with the knowledge and tools they will need to maintain sound financial habits over a lifetime.
- **Show Business:** Introduced by the Federal Reserve Bank of Boston, provides learning activity on economics and the entertainment industry. The goal is to offer an extra instrument for instruction and learning about basic economic concepts.
- **Financial Entertainment:** Developed by Doorways to Dreams Fund in 2009, has been established as a valuable tool for improving financial knowledge and self-confidence for the player. Financial Entertainment is a library of free online and mobile games that aim to improve personal financial capability, self-confidence, and knowledge.

By using appropriate game elements and mechanics, organizations can provide self-directed investor tools to play and learn in an easy way, helping individuals make more assertive and efficient financial decisions (Lusardi, 2008). Thus, the game elements and mechanics developed in financial education software, can educate the individuals about money and investments, and improve their financial knowledge (Kiili, (2007).

3. Method

To answer our research question – how well adult self-directed investors understand financial education about complex financial products and portfolio management – and evaluate the financial education level of self-directed bank investors in complex financial products with high risk, we adopted a multiple-choice questionnaire developed in a quiz game context.

Multiple-choice questionnaires/tests are standardized tools that allow assessing and evaluating skills (Dunn, 2002; Scharf *et al.*, 2007). From an extensive review centered on studies that measure information education, we found out that the most popular assessment tools are the multiple-choice questionnaires (Walsh, 2009). Answers maybe graded as correct or incorrect, and total scores are obtained by the sum of correct answers. The number of correct responses can be converted to the percentage of correct responses, dividing the number of correct answers by the total number of questions answered in the quiz game, multiplied by 100. The self-directed investor's financial investment knowledge is assessed through the percentage of correct responses, in a score from 0 to 100 (e.g. 0% to 100%).

3.1. Quiz game

One of the challenges confronting the banking sector is helping to promote the knowledge of financial products, which are usually complex, and the training actions necessary for elucidation of customers about these products. Financial products have terms, features, and risks that are difficult

to value and to predict, and often are not likely to be correctly interpreted by a typical self-directed investor.

At the end of 2012, a Bank (specialist in asset, investment management, and brokerage services) launched a quiz game, allowing individual clients (and users who were not clients) to increase their knowledge about investment products, available on the Bank website. To motivate the individuals, they were offered the chance to win an iPad by playing the game, while answering the quiz with questions about financial education.

The game was developed in partnership with seven Assets Managers institutions, and consisted of seven questionnaires to assess the individuals' knowledge of investment portfolio management and complex financial products. With this quiz game, the Bank also sought to encourage the knowledge and financial education of common investors about relevant financial instruments to diversify the investment portfolio and risk management. In addition, the application was developed to help adults in their financial education and evaluated the clients' knowledge about the investment funds, through multiple-choice questions (Quiz). Upon answering all items in the questionnaires, the participants were automatically directed to the drawing for one of the seven available prizes - attractive iPads.

The game's presentation design (Figure 3) was developed to captivate the participant's attention to the characteristics of these complex financial products, using a game with simple rules, in which they were encouraged to reply, scoring points for each correct answer.



Figure 3. Quiz game: Home Page. (Source: Developed for this study).

Each participant could respond to the seven questionnaires, submitting each of them to each of the asset management institutions, obtaining in return seven numbers to the drawing for the prize. The development of this application, called "Best Quiz", also had the following business goals:

- Promote among clients, and other non-client users, financial knowledge and training on financial products and portfolio management;
- Help all participants through a game of questions-responses to understand the operation of complex financial products, and understand the risks associated with them;
- Increase customers' loyalty to the Bank.
- Promote brand name awareness.

Participants could click on the multiple-choice button to select the proper answer in the quiz game (cf. Figure 4) and then conveniently return to the main menu, to pick out another asset management questionnaire.



Figure 4. Quiz game: Multiple Choice Questionnaire. (Source: Developed for this study).

When a participant finished the quiz game, results and her/his position on the score list appeared. After concluding the questionnaires, she/he received a ticket number and was directly admitted to the drawing to win one of the seven-iPad prizes. Participants could play all seven quiz games (seven questionnaires, one for each of the seven mutual funds managers) getting a drawing ticket for each game played (cf. Figure 5).



Figure 5. Raffle ticket to win an iPad. (Source: Developed for this study).

3.2. Multiple Choice Survey

Financial education metrics are difficult to measure (Lusardi & Mitchell, 2008). Nevertheless, to design a standard set of questions around these ideas, four principles should be followed: 1) Simplicity: the questions should measure knowledge of the fundamental building

blocks to decision making in an intertemporal setting; 2) Relevance: the questions should relate to concepts pertinent to persons' day-to-day financial decisions over the life cycle; moreover, they should capture general, rather than context-specific ideas; 3) Briefness: the number of questions must be kept short to secure widespread adoption; 4) Capacity: questions should differentiate among areas of financial knowledge to permit comparison across individuals. The design criteria (Lusardi & Mitchell, 2008) were applied to construct three multiple-choice questions (Rodriguez, 2005) in all seven questionnaires.

Additionally, two lots of questionnaires were produced with different degrees of knowledge complexity, to evaluate the individual perceptions on financial education in their two main skill categories: basic or common sense knowledge level (core competencies), or advanced level (advanced skills) of financial education skills on complex investment products.

The survey was organized with two main sections. The first consisted of socio-demographic questions (about gender and age). The second focused on testing people's knowledge and skills as they relate to the seven question groups (one by each asset manager). The seven asset managers that collaborated in this assessment defined the seven questions groups with five questions each, resulting in 35 multiple-choice questions (cf. Figure 2).

Two levels of questions complexity were developed, to be randomly presented, in order to evaluate the basic and advanced skills: 1) a generic common sense or basic level, with lower difficulty, was developed in three groups of questions by asset managers, Amundi, Eurovida, and Threadneedle; 2) a higher level with complex questions was developed in four groups of questions by asset managers, Fidelity, FTI, Nordea, and UBS. Moreover, the basic skills group contains questions about individual knowledge of financial markets and investments, measuring common sense financial education. The advanced skills group contains questions about investment in complex financial products and portfolios management knowledge, measuring advanced financial education.

There is a diversity of financial education conceptual definitions, and different methods are used to measure financial education (Hung *et al.*, 2009). In our study we calculate the individual score by the amount of correct answers from the three multiple answers quiz questions (Lusardi & Mitchell, 2008). The quiz game software, and the questionnaire, was hosted on the Bank website.

3.3. Survey Test

Before deploying the quiz game, the questionnaire was previously validated, to test and measure the financial information education in three steps: 1) the questions were adapted from another similar test made by the Asset Managers institutions (to customers of other banks); 2) a small group of bank customers and employees performed the grammatical and structural test of the proposed questions, to ensure comprehensibility, and to give an indication of the difficulties of

financial quiz questions; 3) the test scores were compared with similar previous tests already conducted by Asset Managers. All three steps revealed that the questionnaire had construct validity.

3.4. Participants

The survey was available for approximately one month on the Bank website to clients (already clients of the bank) and other users/visitors (not clients of the bank), all designated as “participants”. All questions and answers were coded, and stored in the database that supported the game application. Each participant (as a self-directed investor) received a total score from 0 to 100 based on her/his answers, for each group of five questions.

We had a sample of 1,597 participants, 87% were clients, and 13% were visitors (cf. Table 1), 81% were men, all were adults, and the age group from 30 to 39 years old was the most representative (46%). Education was measured as falling into one of three categories: high school, Bachelor’s Degree, and Master’s degree or higher. The majority of participants in our sample have a Bachelor's degree (58%).

Table 1. Participants (Source: author).

Participants	N	%
Clients	1,382	87%
Visitors	215	13%
Total	1,597	100%
Gender	N	%
Men	1,290	81%
Women	307	19%
Total	1,597	100%
Age	N	%
18-29 years old	218	14%
30-39 years old	742	46%
40-59 years old	511	32%
60-86 years old	126	8%
Total	1,597	100%
Education	N	%
High school	399	25%
Bachelor’s degree	926	58%
Masters or higher degree	271	17%
Total	1,597	100%

4. Main Results

In order to understand the financial education among self-directed investors, we analyzed the questionnaire data obtained from Oct/10/2012 to Nov/11/2012. The majority of the answers occurred from Oct/10 to Oct/18 (cf. Figure 6).

Questionnaires

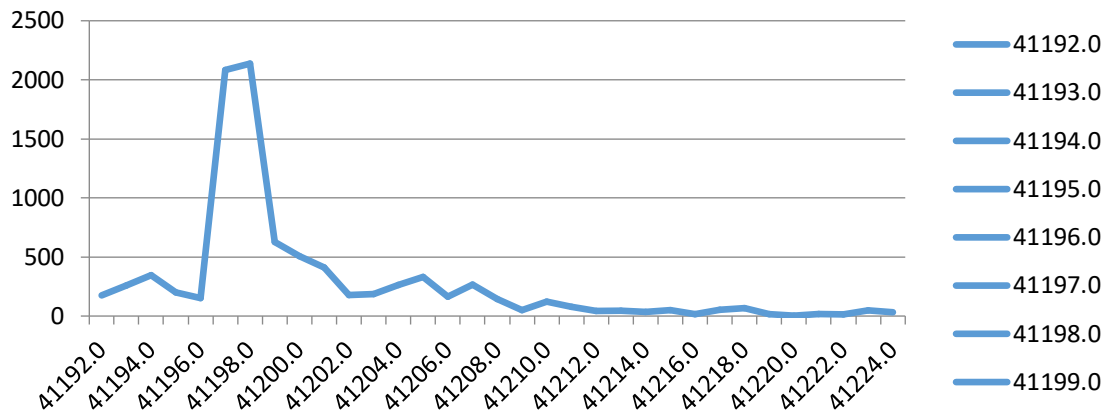


Figure 6. Questionnaire responses over time (Source: author).

At the end of the game, the 1,597 participant had answered to 9,118 questions, in which Eurovida and Amundi had the highest number of responses (cf. Figure 7). The answers to the Asset Managers questionnaire present a general equilibrium of responses from 13% to 16%, showing an overall interest in all questions (cf. Figure 7).

Questionnaires answered by Asset Managers

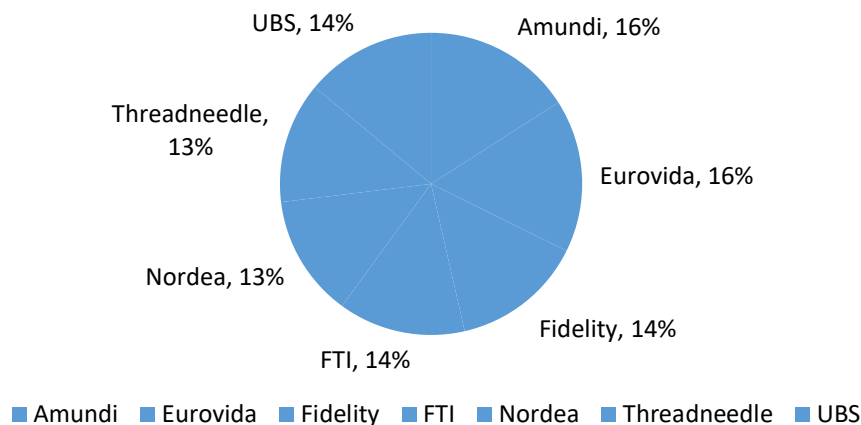


Figure 7. Breakdown of responses. (Source: author).

To evaluate the individual investor's knowledge toward financial education we analyzed the score of each group of questions by degree of difficulty (three groups for basic skills and four groups in advanced skills). For each questions groups define by the seven Asset Managers questionnaires, the participants had three possible answers, and only one was correct (Table 2).

Table 2. Survey Results. (Source: author)

Questionnaire	Difficulty Degree	Score (0 to 100)
Amundi	Basic skills	86
Eurovida	Basic skills	84
Threadneedle	Basic skills	86
Core competencies Average		85
UBS	Advanced skills	65
Fidelity	Advanced skills	62
FTI	Advanced skills	61
Nordea	Advanced skills	64
Advanced skills Average		63
Global Average		81

Some questions required more technical, economic, and financial knowledge (e.g., Advanced Basic skills, average 63 out of 100), while others are more ‘common sense’ (e.g., Core competencies, average 85 out of 100). The overall average score of correct answers was 81 out of 100, indicating a satisfactory level of self-directed investors’ financial education knowledge (cf. Figure 8).

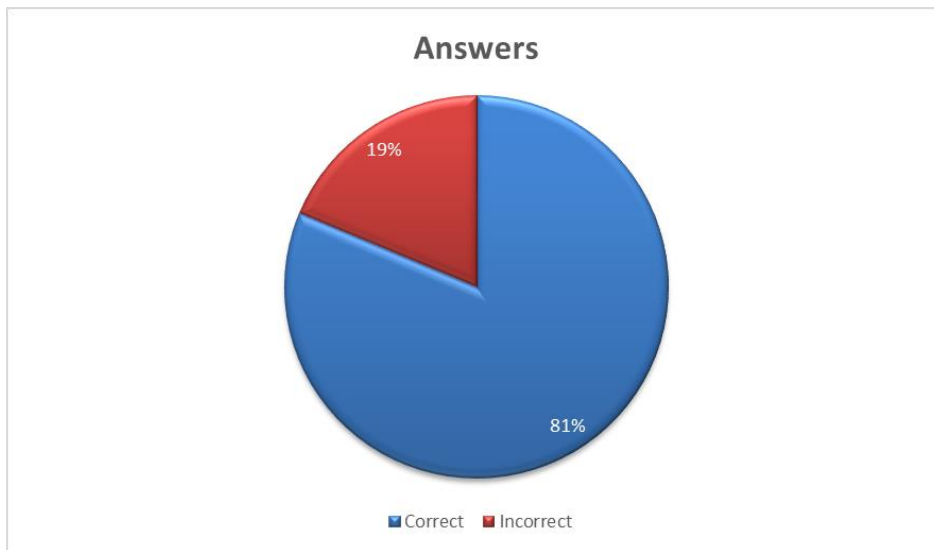


Figure 8. Overall Survey Results. (Source: author).

Each of the seven multiple-choice quizzes consisted of five questions, each with three possible answers (having only one correct), and participants could continue the quiz only if they achieved three correct answers. Thus, the probability of a participant passing the quiz by randomly guessing the answer to each question is a binomial problem with $n = 5$, where $p(\text{correct}) = 1/3$ is 0.2099 ($P(3 \leq x \leq 5) = 1 - \text{binomcdf}(5, 1/3, 2) = 1 - 0.7901 = 0.2099$). Thus, participants not viewing and judging the questions had only a 20% chance of selecting the correct answer.

On average, all participants, independently of gender, age, or education, scored more than 80 out of 100 (cf. Table 3). Women, aged from 60 to 86 years old, and those with a Bachelor's degree scored higher than the other groups of participants.

Participant groups	Score (0 to 100)
Gender	
Men	81
Women	83
Age	
18-29 years old	83
30-39 years old	81
40-59 years old	80
60-86 years old	84
Education	
High school	80
Bachelor's degree	82
Master or higher degree	81

Table 3. Participants group scores. (Source: author).

The two groups of questionnaires, according to the degree of difficulty, divided participant's scores in order to assess basic and advanced skills (cf. Table 4). We verified that participants scored higher in the questionnaires with lower difficulty degree (more than 80 in 100), and lower in the questionnaires with higher difficulty degree (less than 70 in 100), except in the group with age between 18 and 29 years old, which scored 78 out of 100. Women scored higher in the questionnaires with a higher difficulty degree (69 out of 100).

Participants with less education (high school), showed lower scores in both difficulty groups, enhancing a difference with the questionnaires group with a higher degree of difficulty (59 in 100). Table 4. Score by questionnaire difficulty level degree (Basic and advanced skills). (Source: author).

Difficulty degree	Score (0 to 100)	
Gender	Basic skills	Advanced skills
Men	86	63
Women	85	69
Global Average	86	64
Age	Basic skills	Advanced skills
18-29 years old	84	78
30-39 years old	85	63
40-59 years old	86	60
60-86 years old	88	60
Education	Basic skills	Advanced skills

Difficulty degree	Score (0 to 100)	
High school	84	59
Bachelor's degree	86	65
Master or higher degree	86	66

5. Discussion

Earlier work on financial education tended to focus on young people and students, which is likely to be partly endogenous with regard to advanced financial investment experience. In the present study, the majority of participants are adults with 30 to 39 years old (46%). All participants (N=1,597) responded to the seven sets of questions (mutual funds managers' questionnaires), with: common sense questions (concerning basic skills), and more complex questions (concerning advanced skills) on financial knowledge.

Results indicate that participants have a very satisfactory financial education degree, achieving an overall score of 81 out of 100, which indicates a high level of financial education about complex products. This high score might be related to the fact that most participants were clients of the bank, which was specialized in asset management, an area in which the quiz game was centered. By contrast, the answers to the questionnaires with a higher (or advanced) difficulty degree in financial education revealed that the self-directed investors' scores are lower (around 60 out of 100) showing moderate skills in complex financial education, as was expected (Aribawa, 2017). This is especially important not only in terms of finance literature, but also for the financial institutions, regarding individual assessments about complex financial products and the extent to which individuals are well informed and aware of the risks involved in investing in this type of financial product.

Findings by questionnaires' difficulty levels (low and high) show a gap (approximately 20 points) between the core and advanced skills knowledge in education concerning investing in complex financial products. Gender, age, and education levels (OECD, 2013) influence financial education levels. When it comes to high difficulty questionnaires, the women in our sample had higher scores (69 out of 100) than men (63 out of 100). Studies corroborate that women performed better in portfolio management, net returns, and tend to be less financially literate (e.g., Lusardi & Mitchell, 2008; Bauer *et al.*, 2009). However, some other studies find that women have less knowledge about finance topics (e.g., Chen & Volpe, 2002; Lusardi & Mitchell, 2011). Also, the individuals in the age group of 18-29 years old are better prepared with financial knowledge of complex products (score 78 out of 100), showing a gap of 18 points with the age group of 40-86 years old. However, age is intrinsically related to investor's experience and studies. For example, Bauer *et al.* (2009) and Korniotis & Kumar (2011) found a negative impact of age on investment performance, providing evidence that older people and investors that are more experienced have greater knowledge regarding investments.

Nevertheless, these results also suggest that the gender gap in critical domains of risk investment decision making can be reduced with appropriate control for financial education and information/education initiatives by financial organizations. Earlier works on financial education found that adult men and women differ on economic issues and about financial education (Almenberg & Dreber, 2015). Therefore, the improvement of our understanding of links between financial education and economic decision making is also important for interpreting the gender differences observed in financial investment issues, namely in complex financial products.

When it comes to lower difficulty questionnaires, the scores are on average uniform across all groups, moving from 84 (e.g., 18-29 years old and high school) to 88 (e.g., 60-86 years old) out of 100. Earlier studies on financial education have not focused on explaining the adult's gap in common sense and advanced knowledge in financial education of investment products.

The individual investor knowledge on more complex questions is significantly weakened in the participants with a lower education degree, and with ages from 40 to 86 years old. This situation has raised concerns that the cognitive decline that comes with age, and that is associated with a lower education degree, may compromise the investment decision-making ability and thereby financial well-being (Finke *et al.*, 2016).

The results observed for self-directed investors are important because almost 90% of financial education studies do not provide an indicator of adult's financial education threshold and a grading system to interpret the measured results (Huston, 2010). For example, a respondent of a financial education test with a score of 70 or better (out of 100) is considered a literate person in investment (Volpe *et al.*, 1996). Another example, a respondent of a financial education test with a score below 60 out of 100 is considered a non-literate person in investment (i.e., the person fails in the test) (Mandell, 1999). Moreover, individuals are financially literate if they score 75 or more (out of 100), however for scores from 60 to 74 out of 100 it is unclear to define their actual knowledge (Mandell & Klein, 2009).

Therefore, according to our results the participants can be considered as literate in investment (having an average score of 81 out of 100). However, analyzing our results in more detail, they probably have severe financial education difficulties, suggested by an average of 64 out of 100, scored in the advanced financial education tests, which were more difficult than the other tests. In fact, this poor result suggests that individual comprehension of complex financial products is minimal, and might not be sufficient to guarantee that self-directed investors are in a position to make good financial decisions regarding complex financial products, which is according to findings reported in other studies (e.g. Atkinson & Messy, 2011; Lusardi & Mitchell, 2011). Our findings also indicate an understanding in this financial education context as it is a self-directed investor's core competencies of the financial products' characteristics, risks, and benefits, compared with other types of investment.

6. Conclusions, Limitations, and Future Work

Financial training is a form of action, which is helpful for people to acquire a fuller understanding of monetary products, services, and concepts. Financially educated individuals are better able to make investment selections and more prepared to react to financial market volatility. In sum, the self-directed investors are well informed in relation to core financial education. However, they reveal insufficient knowledge, skills, and financial education regarding advanced complex products.

Additionally, women are better prepared in advanced skills, knowledge about investment in complex financial products, and portfolio management than men in general individuals in the age group of 18 to 29 years old. We may accept that these participants, evaluated with a high score (more than 80 out of 100), have the power to formulate and execute investments, and handle their financial portfolios, which calls for them to have the ability to manage complex financial products. Yet, as shown by the overall advanced skills results, individuals, in general, seem to have a lower financial knowledge (around 60 out of 100), and so they may be considered as non-literate in complex financial products. Therefore, performing financial investments in complex and high-risk products, based on their own judgments, is likely to make them lose money, due to their lack of comprehension about those products.

Finally, we highlight that it is actually advantageous to financial organizations to inform people and help their clients to be financially literate. Financial education is critical to avoid wrong decision-making. A financially literate person will be better prepared to deal with financial market volatility, and understand their actions toward investment decisions, with or without a personal financial advisor's support.

Thus, it is important to promote financial education using attractive and straightforward games tools to improve the individual investors' financial education, and empower them with an effective financial education.

There are several limitations (e.g., the lack of financial education definition, the content of the measurement instrument, and results interpretation) to a standard financial education measure (Huston, 2010). Therefore, not having a precise and consistent construct concept limits the ability to compare analyses or to assess financial education scores, and their subsequent impact on the evaluation of investor's knowledge. Studies exploring other types of games with a different sample profile and other types of questions should be addressed in future works to compare results, namely to study the gap between general perceptions of men and women, and age groups.

This paper contributes to the growing literature linking financial education to investing in complex financial products. We also make an important contribution to financial education research by using standard measures to evaluate complex product knowledge, by distinguishing between basic and advanced skills and financial education, and by using a random sample that is broadly representative of the adult population with an investment bank account. This study may also be

particularly useful for policy makers, regulators, and banks who prioritize financial inclusion and financial education, or who are introducing financial education strategies according to the high-level principles developed by financial organizations.

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