Inclusion of Financial Literacy Goals in Secondary School Curricula: Role of Financial Mathematics

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Abstract

The best policy option to implement financial education at school is still open for debate. We add to this discussion by examining the possible contribution of financial mathematics in the curriculum of secondary schools. Results of an exploratory study based on a pre-posttest design show that financial mathematics positively affects students' general financial literacy levels in the short run by raising their understanding of (math-related) financial literacy concepts and the application of financial math methods to the financial world. The effect is stronger for female students suggesting that financial mathematics can help reducing the gender-related financial literacy gap. Spillover effects to other financial literacy topics not covered in financial math curriculum are not present. Overall, financial mathematics appears to be a valuable course in an integrated cross-curricular approach to financial education.

Keywords

Consumer education, Curriculum design, Educational finance, Financial literacy, Mathematics of finance

Introduction

Financial illiteracy is widespread and has important economic consequences, so the need to increase the level of people's financial literacy is generally recognised (Lusardi & Mitchell, 2014). Research especially demonstrated the low level of financial literacy of different social sub-groups, such as youth, women, lower-income people and weakly-integrated immigrants (Chen & Volpe, 2002; De Bassa Scheresberg, 2013; Erner, Goedde-Menke, & Oberste, 2016; Lusardi, Mitchell, & Curto, 2010; Mandell, 2008a; Xu & Zia, 2012). Initiatives that may empower these vulnerable groups receive ample attention in recent research and developmental actions on financial literacy (Blue, O'Brien, & Makar, 2017; Sawatzki, 2017). In its efforts to specifically combat financial illiteracy of young people, the Organisation for Economic Co-operation and Development (OECD) recommends that financial education starts at school to ensure exposure at an early age (OECD, 2005). There is a broad consensus to start improving financial literacy early because sound financial behaviour developed at a young age acts as a catalyst for sensible financial behaviour later in life (Beverly & Burkhalter, 2005; Martin & Oliva, 2001). Adolescents are already confronted with various financial options at a young age (saving and spending, bank accounts, online shopping, cell phone plans, …). Over their lifetime they are also likely to be confronted with more complex and riskier financial products than their parents (Lusardi et al., 2010; OECD, 2014a).

It is thus not surprising that financial literacy programs for schools take a prominent place in youth financial literacy policies worldwide. Delivering financial education at school has a number of distinct benefits (see, amongst others, Messy, 2011; OECD, 2014a; Van Campenhout, 2015). Firstly, it indeed ensures that financial literacy is introduced at an early age and that aspects of financial literacy can be introduced

gradually over the curriculum. In addition, childhood represents many teachable moments with potential stronger impacts on desirable financial behaviours and the development of sound financial attitudes.[i] Secondly, it ensures that all children will be reached. Without school-based financial literacy initiatives we run the risk that financial illiteracy carries over from one generation to the next, thereby reproducing or even amplifying inequalities over time (Messy, 2011). Indeed, previous research has documented that financial literacy levels tend to be positively correlated with socio-economic status, but also that children from less wealthy families may receive less financial education at home (De Bassa Scheresberg, 2013; OECD, 2013, 2014b; Shim, Barber, Card, Xiao, & Serido, 2009).

In view of the arguments raised above, including financial education in the official school curriculum is considered one of the most efficient policy options to deliver broad-scale financial literacy initiatives (OECD, 2014a). Such initiatives can be mandatory or on a voluntary basis. There is however no consensus on how this policy can best be implemented in the existing educational structures. Indeed, the optimal manner in which financial literacy goals can be integrated in curricula and the best way to expose children to financial literacy at school are still open for debate. Financial literacy could be given as a stand-alone course, as an explicit module in one or more courses, or integrated in relevant courses such as mathematics, economics, citizenship, etc. (OECD, 2012b). Although a stand-alone course has the advantage that students would get sufficient exposure to financial literacy subjects, it is often difficult to implement in view of overloaded curricula and lack of resources and time (OECD, 2014a). In this respect, it is not surprising that the majority of countries that include financial education in the curriculum have done so by integrating it into several courses through a cross-curricular approach (OECD, 2012a). Mathematics is the most popular

course that is considered to implement financial education goals, probably due to the established positive association and theoretical connectedness between financial literacy and mathematical skills (Lusardi et al., 2010; OECD, 2014a).

Financial literacy and mathematics

The positive relation between mathematical competence and financial literacy is widely recognized in the literature. Mathematical ability is often an implicit or explicit part of definitions of mathematical literacy (see, e.g., Worthington, 2006) and of instruments to measure financial literacy (see, e.g., Lusardi & Mitchel, 2011; OECD, 2014c). Cole, Paulson, and Shastry (2014, 2016) were able to establish a causal relation between increased US state math requirements and superior financial outcomes, including greater market participation, higher investment income, better credit management and lower probability of being delinquent on a loan. They further showed that this result was driven by improvements in investment performance, rather than by increased labour income. Similar results were found by De Bassa Scheresberg (2013) who showed that young adults who displayed higher confidence in their mathematical knowledge demonstrated better financial behaviour. More specifically, they were less likely to engage in high cost borrowing behaviour and were more likely to have precautionary savings or retirement savings.

Detailed accounts of the relationship between adolescents' financial literacy and mathematics in several regions around the world were provided by the 2012 and 2015 Programmes for International Student Assessment (PISA) on financial literacy, conducted in, respectively, 18 and 15 countries (or economies) with a total of about 29 000 and 53 000 15-year-old students participating (OECD, 2014c, 2017). An important conclusion is that financial literacy and mathematical literacy are highly correlated (on average across the participating OECD countries and economies, $r = 0.83$

in PISA 2012 and $r = 0.74$ in PISA 2015), although they do not coincide completely. Another way of looking at this relationship is the percentage of the total variation in financial literacy scores that can be explained by mathematics. On average about 12% of this variation across OECD countries and economies can be attributed to mathematics in PISA 2012, compared to 6% in PISA 2015. Comparing financial literacy scores of students with comparable math skills, there is a wide dispersion in the documented financial literacy proficiency. PISA 2012 revealed that in some well-performing countries such as the Czech Republic and Australia, levels of financial literacy proficiency are more than 15% higher than what could be expected based on mathematical proficiency levels, while in other, weak-performing countries such as France, levels of financial literacy proficiency are about 25% lower than those of students with comparable math proficiency. For the Flemish Community of Belgium, the region in which the study reported in this paper was conducted, financial literacy scores are significantly above OECD average and about 9% higher compared with matched participants, while the overall correlation between math and financial literacy ($r = 0.86$) is just above average. Also in PISA 2015, the actual financial literacy scores are different from the ones expected on the basis of math performance across countries. For a detailed overview, we refer to the official PISA report (OECD, 2017), but in the Flemish Community of Belgium, financial literacy scores are again significantly above OECD average and about 14% higher than those of participants matched on math proficiency, while the overall correlation between math and financial literacy is above average ($r = 0.80$). In sum, the reported PISA results suggest that although financial literacy is not solely determined by mathematical competence, mathematical skills taught at school will help students to attain higher levels of financial literacy.

The course in which the financial literacy-mathematics association can be maximally exploited is financial mathematics. Financial mathematics is a compulsory or optional part of the secondary mathematics curriculum in several countries. We empirically examine the possible contribution of financial mathematics to help raise students' financial literacy levels. Therefore, we compare financial literacy scores of students before and after they have attended a financial mathematics course. By doing so, we can gain insight in the students' progress in financial literacy levels. Our experimental approach, based on a pre-posttest design, is different from previous, mostly correlational research that concentrated on the possible cross-sectional association between financial literacy and mathematics at an aggregate level (cf. supra).

As mentioned, our study was conducted in the Flemish Community of Belgium. This community provides an interesting case for two reasons. Firstly, in 2016 the Flemish Minister of Education announced the introduction of financial literacy as one of the four basic competences (besides Dutch, mathematics and digital competences) for the secondary curriculum (Crevits, 2016), but the actual design regarding the implementation is still unsettled. Hence, research to support this decision is more than welcome. Secondly, the Flemish financial math curriculum goes beyond a straightforward review of math-technical aspects and explicitly focuses on the application of math concepts to the financial world (Deprez, Eggermont, & Roels, 1996). Note that this approach is closely related to the one in England. The national mathematics curriculum (stage 4) indicates that:

> 'They [students] should also apply their mathematical knowledge wherever relevant in other subjects and in financial contexts.' (Department of Education, 2014, p. 3)

In line with (Davies, 2015, p. 311) who argues that financial decisions do not take place in a vacuum but arise from a system that determines the context in which individuals, financial services and government interact, the financial math curriculum in the Flemish Community also stresses the link with the economic and legal climate:

> 'The theoretical knowledge cannot be viewed separately from reality. As future consumers, pupils need to become proficient in an assessment of the ample supply of products and services in the financial world. (…) Financial mathematics is strongly interrelated with the prevalent economic climate and legislation. As a result, teachers should keep abreast with the evolution of interest rates, withholding tax rules and other relevant regulations, etc.' (VVKSO, 2004, pp. 54–55).

This holistic approach to mathematics and its applications is also reflected in the secondary mathematics curriculum in England. Indeed, the secondary national curriculum highlights the importance of mathematics to both everyday life, alpha sciences and its applications (science, technology and engineering), as well as its necessity for financial literacy and most forms of employment (Department of Education, 2014, p. 3).

Overall, the current practice in the Flemish Community is commensurate with the call in the financial literacy education literature to move towards initiatives that would stimulate effective financial behaviour (i.e. result in successful application of the acquired financial knowledge and skills), and away from initiatives that only aim at increasing financial knowledge. The latter has been criticized for assuming an automatic causation running from improvements in financial knowledge to positive changes in desired financial behaviour (see among others García, 2013; Van Campenhout, 2015). This study will also indirectly show whether in terms of curriculum development such

an application-driven learning approach hold promise to achieve financial education objectives. In view of the parallels between the Flemish approach to mathematics and the one put forward in other countries like the UK, our results based on Flemish students could also be insightful for the implementation of financial literacy programmes in other countries.

Because financial mathematics is not part of all Flemish secondary schools curricula,[ii] results of this study also stimulate the discussion regarding the inclusion of financial mathematics in the curriculum, both in Flanders and internationally. On a broader scale, this study provides further insights on the implementation of financial literacy objectives through a cross-curricular approach.

Material and methods

Eighty-four 16–18-year-old secondary school students in the Flemish Community of Belgium, for whom financial mathematics is part of their math curriculum,[iii] participated in the study. The sample group was subjected twice to a financial proficiency test: A pretest – taken just before the start of the financial mathematics course – and a posttest just after they have taken the financial mathematics course. Post- and pretest were equivalent, which was established by a panel of experts.

The written tests consisted of 21 multiple-choice questions regarding financial literacy. Questions covered a variety of basic financial topics and were chosen from existing tests designed to measure financial literacy among adolescents (Lusardi & Mitchel, 2011; OECD, 2014c) or were specifically constructed for this experimental research action. Each question had four alternative answers. For further analysis, questions were categorized into the following three categories: (1) financial mathematics methods; (2) financial mathematics concepts; and (3) spillover effects. Categories were not disclosed to participants and the questions were randomized over

categories and tests. For the sake of brevity, we refer to the three categories as ‘Methods’, ‘Concepts’, and ‘Spillovers’ in the remainder of the article. The first two categories of financial literacy questions refer to the learning content of the financial math curriculum. ‘Methods’ consists of financial literacy questions in which students have to apply mathematical methods that have been reviewed during the financial math lessons. Typical questions are about the application of simple and compound interest rate calculations, discount calculations, and applications related to annuities and loans. The second category ‘Concepts’ refers to questions that test aspects that belong to the context of the financial math lessons, but the answer does not require the students to perform any kind of calculation. Examples include questions on the concepts of checking and savings accounts, loans and purchases by deferred payments, etc. The final category ‘Spillovers’ consist of questions that test issues that are not part of the learning outcomes of financial mathematics, but are part of financial literacy. Examples of topics include questions related to diversification, insurance, stock market, safety of financial transactions, etc. Worded differently, these questions test whether financial math competencies also generate spillover effects to other domains of financial literacy that are not explicitly reviewed in the financial math course. The test also included a number of general questions related to the participant’s personal background or social status, allowing us to control for personal and social correlates documented in the previous literature. Besides age, gender, local speech used in a family setting, also results on math and language proficiency and experience with money were surveyed. The financial literacy questions of the test are added in an Appendix.

Hypotheses

Our main focus is to examine whether financial mathematics could help promote financial literacy at school. Previous research has documented a positive relationship

between mathematical proficiency and financial literacy. In addition, OECD advocates exposing young people to financial education in a scholarly environment. So we first hypothesize that financial mathematics positively affects students' financial literacy. In particular, we predict that this progress will manifest itself with respect to skills and knowledge covered by the financial algebra curriculum. Consequently, we expect that students who attend a financial math course will improve their financial literacy scores, both in general, and in particular on the categories 'Methods' and 'Concepts' as identified in the section Research design.

In addition, it is important to gain a more detailed insight into which financial literacy aspects are addressed effectively (or not) in order to develop a cross-curricular approach to financial literacy. Indeed, it is unlikely to assume that current financial math courses provide an all-in-one solution to financial education. We investigate the differential effect of financial mathematics for the three categories of financial literacy questions ('Methods', 'Concepts', and 'Spillovers') as identified in the section Material and methods. It is likely that students' progress with regard to financial literacy aspects that are covered in financial mathematics is more explicit. Hence, we hypothesize that the progress in financial literacy after the completion of the financial math course is higher for topics covered by the financial mathematics curriculum compared with topics not targeted in this curriculum. In line we predicted a higher increase in students' financial literacy scores from pre- to posttest for the categories 'Methods' and 'Concepts' than for the category 'Spillovers'.

Finally, we examine the possibility of a gender effect. It is difficult to postulate an expected relationship a priori. On the one hand, the 2009 PISA study found that in the majority of countries (including Belgium), boys outperform girls in mathematical skills (OECD, 2011). In addition, males have higher financial literacy levels than

females. On the other hand, based on a study of 34 schools in the Flemish Community, Van Houtte (2004) found corroborative evidence that boys underperform girls in terms of academic achievement. With respect to general schools – which are also the subject of this study – they conclude that the difference is attributable to boys' study culture (showing less student involvement and learning motivation than girls' culture). While the former might support the hypothesis that boys might benefit more than girls from financial mathematics, the latter is supportive for an opposite effect: the academic outperformance of girls compared with boys might result in a more distinct positive change in financial literacy. Given that the sign of the gender effect is an empirical issue, we formulate the general hypothesis that the effect of financial mathematics on students' financial literacy is different for female students (compared with male students).

Results

We apply a pre-posttest design in which subjects take a written financial literacy proficiency test before and after they have taken a financial math course in order to examine the (short term) effects of financial maths on various aspects of financial literacy. Results are reported for seventy students that took both the pre- and posttest.

Insert Table 1 about here

We first examine the effect of financial mathematics on the average level of financial literacy, as well as its effect on financial literacy aspects related to the methods and concepts of financial maths. Results are summarized in Table 1. Differences between the mean scores in the pre- and posttest are evaluated based on a paired sample T-test. The results provide a strong confirmation of our hypothesis concerning students'

progress on financial literacy: With the exception of the category ‘Spillovers’, the average score on the posttest is significantly higher than on the pretest (*p*-value of a paired sample T-test is lower than 0.001 in each instance). These results support our expectation that financial mathematics can help promote financial literacy in general, and financial literacy skills and knowledge in particular.

In additional analyses, we investigate whether the documented positive effect is different for the three subcategories. The respective hypothesis is confirmed too. Based on an ANOVA analysis and accompanying Tukey HSD-tests we find that there is a significant difference between the effect on the two financial mathematics categories (‘Methods’ and ‘Concepts’) compared with the category ‘Spillovers’.[iv] Comparing the category ‘Methods’ with the category ‘Concepts’, we do not find a significant difference, indicating that the holistic approach of financial math teachers in which they do not only focus on the math-technical aspects results in a broader impact on students’ financial literacy.

To investigate a possible gender effect, we analyse the effect of financial math separately for male and female students. Results reported in Table 2 indicate that the effect of financial maths is not identical for male and female students. The difference in pre- and posttest scores is 2.78 for female students and only 1.26 for male students. The gender effect is also significant at conventional levels of significance (*p*-value equals 0.019). Hence, female financial literacy levels increase more compared with male financial literacy levels. Subsequent ANOVA analyses reveal that the gender effect is attributable to a stronger significant increase for females on ‘Concepts’ which might be indicative for the fact that girls superior study culture pays dividends. This result is encouraging in view of the generally documented lower average financial literacy level

of women. It indicates that including a financial math course in the curriculum can help to level off gender-related differences in financial literacy.

Insert Table 2 about here

The effect of financial mathematics on financial literacy may be related to general math and language skills. In addition, the possible benefit from following a financial math course may be conditional upon the level of financial socialization received at home. Overall, we observe that these variables are unrelated to the documented increase in financial literacy. Regarding financial socialization, we find no significant differences between changes in financial literacy in the pre- and posttest for students that score high or low on financial socialization based on a Kruskal-Wallis test (*p*-value, 0.751). Similar conclusions are reached when we investigate the relation between financial socialization and 'Methods', 'Concepts', and 'Spillovers'. Turning to math and language skills, no evidence is found for a significant positive correlation between these skills and the documented overall effect on financial literacy or any of the subcategories.[v]

In short, the progress in financial literacy associated with the completion of a financial math course is not conditional upon previous levels of financial socialization or math and language skills. Hence, results seem to indicate that financial mathematics can help promoting financial literacy for all students, not only the gifted or weak ones. As such, this strengthens the case for including financial mathematics in the curriculum as a means of promoting financial literacy given that the course is relevant for all students.

To move beyond the average effect of financial math on financial literacy, we provide a more in-depth insight in the evolution of individual students based on the transition matrix in Table 3. This matrix shows the number of units that a student's financial literacy score has increased or decreased compared with his/her initial result on the pretest. For instance, the last column shows that there were two students with a score of 18 on the pretest of which one has increased his/her score with one unit, while the other scored two items lower (i.e. they obtained a posttest score of 19 and 16 respectively). Overall, most students (77.14%) increase their test result in the posttest. Except one, all of the 13 students that failed the pretest improve their result, although not always sufficiently to pass the posttest. Only a single student passed the pretest but failed the posttest. In unreported results, we perform a similar analysis for the subcategories 'Methods', 'Concepts' and 'Spillovers'. Overall, a similar picture emerges, except for 'Spillovers'. After the completion of the financial math course, more students increase their test scores, although the increase is somewhat less pronounced (average increase of 1 or 2 items). More students nevertheless pass in the posttest. For the category 'Spillovers' about 40% of the students remain at the same level. The number of students that passed the pretest in this category is however already quite high (72,61%)[vi], making the lack of progress somewhat less problematic. Nevertheless, if curriculum developers would like to address the financial literacy issues that are in the 'Spillovers' category, it follows that these issues should be dealt with in other courses in the curriculum, or alternatively, would require a revision of the current financial math learning plan.

Insert Table 3 about here

Conclusions and discussion

In view of the need of scholarly initiatives to increase financial literacy, integrating financial education in existing courses appears to be the most realistic option in view of the overloaded curricula and lack of resources (OECD, 2014a). We contribute to this discussion by investigating the possible role of financial mathematics. Given the similarities of the approach to mathematics in the Flemish Community and other countries like the UK, our results may also be relevant for the development of financial literacy programmes in other countries. Results of our exploratory study are promising: Average financial literacy scores increase after the completion of a financial math course. The positive effect is not limited to a better understanding of math-technical aspects but also encompasses broader applications of the concepts to the financial world. In addition, female students benefit to a larger extent, which is encouraging This is encouraging in view of the evidence that female financial literacy levels are generally lower than those of their male peers (Chen & Volpe, 2002; Fonseca, Mullen, Zamarro, & Zissimopoulos, 2012; Lusardi & Mitchell, 2008; Mahdavi & Horton, 2014). Financial mathematics could thus help to narrow the gender gap.

We acknowledge that this exploratory study does not provide a definite answer on this issue, but we hope that these initial results may spur further research to broaden our understanding on how financial literacy can be integrated in school curricula in general, and on the way that financial math can facilitate this process specifically. Firstly, additional quantitative research, based on financial math learning plans in different countries and examining larger sample sizes, would be welcome. The additional variation in relevant characteristics will help in providing a more fine-grained picture of the significant population characteristics. Secondly, we focus on a possible

short-term effect, while effective financial literacy education needs also to generate long-term effects as well. Hence, retention studies would broaden our understanding on this issue. Thirdly, it remains unclear whether students' increased financial literacy scores actually affect their individual behaviour, i.e. taking more responsible financial decisions in their own best short- and long-term interests (Mandell, 2008b). Controlled experiments in which students are put into fictitious life situations (see, e.g., Carlin & Robinson, 2012) can reveal whether the financial knowledge students acquired in a school context leads to behavioural effects in real life. Fourthly, if financial math helps to increase financial literacy, we also need a better understanding of the way that this effect is generated. Hence, additional qualitative research that focuses on the actual learning processes and intermediating personal and psychological factors is warranted. By doing so, we would be able to maximize the possible effect for every individual student. In this respect it would also be interesting to examine how the learning environment and class differentiation could lead to further advancements in financial literacy for specific groups. Results in Renne (2001) on classroom math instruction suggest that such an approach could help girls in achieving equitable participation. In addition, it is also recommendable that specific attention would be devoted to the impact of teachers and the student-teacher relationship. Fowler and Poetter (2004), for instance, argue that the selection of competent teachers with significant mathematical knowledge is an important factor in the success of elementary math education in France. Fifthly, results indicate that financial math could be helpful, but is unlikely to provide an all-in-one solution to financial education at school. Worded differently, financial math is likely to be helpful in a cross-curriculum approach of financial literacy, but not as a stand-alone solution. Hence, to arrive at a successful cross-curricular approach to financial literacy, increased knowledge on the overall framework (which course is most

effective for a specific aspect of financial literacy) is needed. Increased insight in how these courses intertwine and reinforce each other would complete this strand of research. Based on this study, financial math is nevertheless likely to be an essential part in this knowledge network.

References

Beverly, S. G., & Burkhalter, E. K. (2005). Improving the financial literacy and practices of youths. *Children & Schools, 27*(2), 121–124.

Blue, L. E., O'Brien, M., & Makar, K. (2017). Exploring the classroom practices that may enable a compassionate approach to financial literacy education. *Mathematics Education Research Journal.* Published online before print August 24, 2017, doi:10.1007/s13394-017-0223-5.

Carlin, I. C., & Robinson, D. T. (2012). What does financial literacy training teach us? *The Journal of Economic Education, 43*(3), 235–247.

Chen, H., & Volpe, R. P. (2002). Gender differences in personal financial literacy among college students. *Financial Services Review, 11*(3), 289–307.

Cole, S., Paulson, A., & Shastry, G. K. (2014). Smart money? The effect of education on financial outcomes. *Review of Financial Studies, 27*(7), 2022–2051.

Cole, S., Paulson, A., & Shastry, G. K. (2016). High school curriculum and financial outcomes: The impact of mandated personal finance and mathematics courses. *Journal of Human Resources, 51*(3), 656–698.

Crevits, H. (2016). *Secundair onderwijs* [Secondary education]. Retrieved December 4, 2017, from http://www.hildecrevits.be/nl/secundair-onderwijs.

Davies, P. (2015). Towards a framework for financial literacy in the context of democracy. *Journal of Curriculum Studies, 47*(2), 300–316.

De Bassa Scheresberg, C. (2013). Financial literacy and financial behavior among young adults: Evidence and implications. *Numeracy, 6*(2), 5.

Department of Education. (2014). *Mathematics programmes of study: Key stage 4, national curriculum in England*. GOV.UK. Retrieved December 4, 2017, from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/331882/KS4_maths_PoS_FINAL_170714.pdf.

De Win, I. (2015). Draagt het vak ‘financiële algebra’ bij tot een betere financiële geletterdheid van leerlingen in het secundair onderwijs? [Does the course ‘financial mathematics’ contribute to improve financial literacy of secondary school students?]. Unpublished master’s thesis, KU Leuven, Belgium.

Deprez, J., Eggermont, H., & Roels, J. (1996). Financiële algebra [Financial algebra]. *Uitwiskeling, 12*(4), 7–40.

Erner, C., Goedde-Menke, M., & Oberste, M. (2016). Financial literacy of high school students: Evidence from Germany. *The Journal of Economic Education, 47*(2), 95–105.

Fonseca, R., Mullen, K. J., Zamarro, G., & Zissimopoulos, J. (2012). What explains the gender gap in financial literacy? The Role of household decision making. *Journal of Consumer Affairs, 46*(1), 90–106.

Fowler, F. C., & Poetter, T. S. (2004). Framing French success in elementary mathematics: Policy, curriculum, and pedagogy. *Curriculum Inquiry, 34*(3), 283–314.

García, M. J. R. (2013). Financial education and behavioral finance: New insights into the role of information in financial decisions. *Journal of Economic Surveys, 27*(2), 297–315.

Lusardi, A., & Mitchell O. S. (2008). Planning and financial literacy: How do women fare? *American Economic Review, 98*(2), 413–417.

Lusardi, A., & Mitchell O. S. (2011). Financial literacy around the world: An overview. *Journal of Consumer Affairs, 44*(2), 358–380.

Lusardi, A., & Mitchell O. S. (2014). The economic importance of financial literacy: Theory and evidence. *Journal of Economic Literature, 52*(1), 5–44.

Lusardi, A., Mitchell, O. S., & Curto, V. (2010). Financial literacy among the young. *Journal of Consumer Affairs, 44*(2), 358–380.

Mahdavi, M., & Horton, N. J. (2014). Financial knowledge among educated women: Room for improvement. *Journal of Consumer Affairs, 48*(2), 403–417.

Mandell, L. (2008a). Financial literacy of high school students. In J. J. Xiao (Ed.), *Handbook of Consumer Finance Research* (pp. 163–183). New York: Springer.

Mandell, L. (2008b). Teaching young dogs old tricks: The effectiveness of financial literacy intervention in pre-high school grades. In T. A. Lucey & K. S. Cooter (Eds.), *Financial Literacy for Children and Youth* (pp. 221–236). Athens, GA: Digitaltextbooks.biz.

Martin, A., & Oliva, J. C. (2001). Teaching children about money: Applications of social learning and cognitive learning developmental theories. *Journal of Family and Consumer Sciences: From Research to Practice, 93*(2), 26–29.

Messy, F.-A. (2011). *Financial education at school international OECD/INFE guidelines*. Paper presented at the FCAC-OECD Conference on Financial Literacy, Toronto, Canada, May 26-27.

OECD. (2005). *Improving financial literacy: Analysis of issues and policies*. Paris, France: OECD Publishing.

OECD. (2011). *Pisa 2009 at a glance*. Paris, France: OECD Publishing.

OECD. (2012a). *Financial education for youth and in schools: OECD/INFE policy guidance, challenges and case studies*. Paris, France: OECD Publishing.

OECD. (2012b). *Guidelines on financial education at school and guidance on learning framework*. Paris, France: OECD Publishing.

OECD. (2013). *Financial literacy and inclusion: Results of OECD/INFE survey across countries and by gender*. Paris, France: OECD Publishing.

OECD. (2014a). *Financial education for youth: The role of school.* Paris, France: OECD Publishing.

OECD. (2014b). *International gateway for financial education: Global database on financial education*. Paris, France: OECD Publishing. Retrieved December 4, 2017, from http://www.financial-education.org/gdofe.html.

OECD. (2014c). *PISA 2012 results: Students and money: Financial literacy skills for the 21st century (Volume VI)*. Paris, France: OECD Publishing.

OECD. (2017). *PISA 2015 results: Students' financial literacy (Volume IV).* Paris, France: OECD Publishing.

Renne, C. G. (2001). A perspective on achieving equality in mathematics for fourth grade girls: A special case. *Curriculum Inquiry, 31*(2), 163–182.

Sawatzki, C. (2017). Lessons in financial literacy task design: Authentic, imaginable, useful. *Mathematics Education Research Journal, 29*(1), 25–43.

Shim, S., Barber, B. L., Card, N. A., Xiao, J. J., & Serido, J. (2009). Financial socialization of first-year college students: The roles of parents, work, and education. *Journal of Youth and Adolescence, 39*(12), 1457–1470.

Van Campenhout, G. (2015). Revaluing the role of parents as financial socialization agents in youth financial literacy programs. *Journal of Consumer Affairs, 49*(1), 186–222.

Van Houtte, M. (2004). Why boys achieve less at school than girls: The difference between boys' and girls' academic culture. *Educational Studies, 30*(2), 159–173.

VVKSO (Vlaams Verbond van het Katholiek Secundair Onderwijs). (2004). *Leerplan secundair onderwijs: Wiskunde – leerplan B: Derde graad KSO/TSO: Studierichting met 3(+1) uur per week* [Syllabus secondary education: Mathematics - curriculum B: Third grade KSO/TSO: Study stream with 3 (+1) hours per week]. Licap: Brussels. Retrieved December 4, 2017, from http://ond.vvkso-ict.com/leerplannen/doc/Wiskunde-2004-023.pdf.

Worthington, A. C. (2006) Predicting financial literacy in Australia. *Financial Services Review, 15*(1), 59–79.

Xu, L., & Zia, B. (2012). Financial literacy around the world: An overview of the evidence with practical suggestions for the way forward. *World Bank Policy Research Working Paper* (6107).

Zia, B. (2013). *Financial education and behavior formation: Large scale experimental evidence from Brazil*. Paper presented at the India-OECD-World Bank Regional Conference on Financial Education in India and Asia, New Delhi, India, March 4-6.

Table 1. Mean and standard deviation of students' financial literacy scores in general and on each of the three test categories for the pre- and posttest

	Pretest	Posttest	Difference pre-posttest
	Mean (SD)	Mean (SD)	
Financial literacy	12.43 (2.806)	14.47 (2.614)	2.04***
Methods	4.24 (1.245)	5.14 (1.243)	0.90***
Concepts	3.11 (1.460)	4.21 (1.261)	1.10***
Spillovers	5.07 (1.171)	5.11 (1.149)	0.04

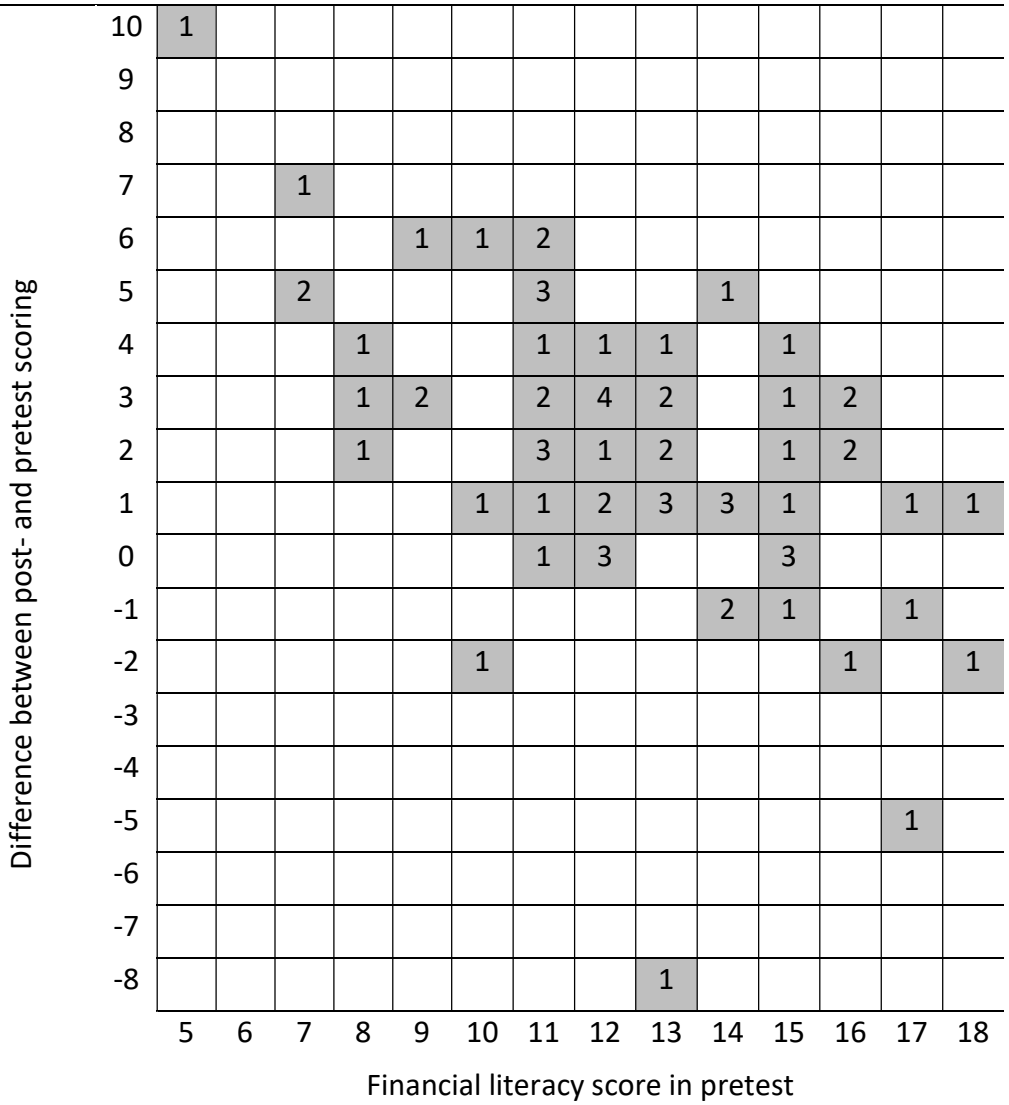
Note: $N = 70$; *** indicates statistical significance at the 1%-level.

Table 2. Mean and standard deviation of the pre-posttest difference scores of female and male in general and on each of the three test categories

Pre-posttest differences	**Female (*N* = 36)**	**Male (*N* = 34)**	**Gender differences**
	Mean (SD)	Mean (SD)	
Financial literacy	2.78 (2.642)	1.26 (2.664)	1.52**
Methods	0.78 (1.533)	1.09 (1.564)	-0.31
Concepts	1.61 (1.517)	0.65 (1.773)	0.96**
Spillovers	0.39 (1.128)	-0.15 (1.760)	0.54

Note: ** indicates statistical significance at the 5%-level.

Table 3. Transition matrix of individual students' financial literacy scores



Note: n = number of students

Appendix. Financial literacy questions of the test sorted by the three categories (Answers are added between brackets)

Items relating to the category 'Methods'

Suppose you have € 1000 on your savings account that pays interest at 1% per year. How much money will be on the account after three years without withdrawing or depositing money?

- ❑ *Less than € 1030*
- ❑ *Just € 1030*
- ❑ *More than € 1030*
- ❑ *No idea*

(Answer: More than € 1030)

Last year you purchased a smartphone for € 200. Today, the same smartphone costs € 150. Which statement is correct?

- ❑ *The price of the smartphone has dropped by 25%.*
- ❑ *The price of the smartphone has dropped by 50%.*
- ❑ *The price of the smartphone has dropped by 75%.*
- ❑ *No idea*

(Answer: The price of the smartphone has dropped by 25%)

Suppose you borrow an amount of € 10 000 at an interest rate of 3%. You can choose to repay that amount on 5 or 10 years. When will you pay the highest amount of interest in total?

- ❑ *If you repay on 5 years*
- ❑ *It is the same in both cases*
- ❑ *If you repay on 10 years*
- ❑ *No idea*

(Answer: If you repay on 10 years)

You have a savings account with an annual interest rate of 2%. You deposit € 200 per year on this account. After ten years you check how much money there is in the account. That amount will be the highest if...

- ❑ *You always deposit the € 200 at the beginning of the year.*

- ❑ *You always deposit the € 200 at the end of the year.*
- ❑ *It doesn't matter if you deposit the € 200 at the beginning or at the end.*
- ❑ *No idea*

(Answer: You always deposit the € 200 at the beginning of the year)

You can invest € 1000 on compound interest at 2% per year or at 1% per semester (= 6 months). Which investment yields the most?

- ❑ *Both are equal.*
- ❑ *Interest at 1% per semester.*
- ❑ *Interest at 2% per year.*
- ❑ *No idea*

(Answer: Interest at 1% per semester)

Suppose you have two types of accounts to which you deposit € 200 once at the same time. Account A pays 2% simple interest per year, account B pays 2% compound interest per year. Which account has yielded the most after three years?

- ❑ *Account A has yielded more than account B.*
- ❑ *The two accounts yielded the same amount.*
- ❑ *Account B has yielded more than account A.*
- ❑ *No idea*

(Answer: Account B has yielded more than account A)

John and Susan each contract a loan of € 10 000 for the same term, namely 5 years, and the same annual interest rate of 3%. John opts for a type of loan with constant capital repayments and Susan for a loan with constant instalments. Who will pay the least amount of interest in total over the entire term of the contract?

- ❑ *In total John will pay less interest.*
- ❑ *In total both will pay the same amount of interest.*
- ❑ *In total Susan will pay less interest.*
- ❑ *No idea*

(Answer: In total John will pay less interest)

Items relating to the category 'Concepts'

Eva wants to buy a car but she hasn't enough money to pay the car directly. That's why she goes for a loan from her bank for which she has to pay each month an amount until the car is paid off. What is this?

- ❑ *A leasing*
- ❑ *An installment sale*
- ❑ *An installment loan*
- ❑ *No idea*

(Answer: An installment loan)

Interest on a savings account is …

- ❑ *An amount that you receive from the bank because you are a long-time customer.*
- ❑ *An amount that you have to pay to the bank because you deposit money on a savings account.*
- ❑ *An amount you receive from the bank because you deposit money on a savings account.*
- ❑ *No idea*

(Answer: An amount you receive from the bank because you deposit money on a savings account)

If you buy this, you actually lend money to your bank. As compensation for that money, your bank pays your interest at fixed moments during a certain term.

- ❑ *A savings certificate*
- ❑ *A government bond*
- ❑ *A share*
- ❑ *No idea*

(Answer: A savings certificate)

A loan in which a property, for example a house, is given as collateral. If the loan cannot be paid off, the property can be sold publicly. What type of loan is this?

- ❑ *An installment loan*
- ❑ *A mortgage loan*
- ❑ *A social loan*
- ❑ *No idea*

(Answer: A mortgage loan)

Which of the following statements about bank cards is <u>not</u> correct?

- ❑ *You can usually withdraw cash 24 hours a day.*
- ❑ *You can usually get information about your account balance at a cash dispenser.*
- ❑ *You can withdraw cash anywhere in the world without having to pay extra.*
- ❑ *No idea*

(Answer: You can withdraw cash anywhere in the world without having to pay extra)

An account that offers easy access to your money for your daily transactional needs. You can deposit money on it, but you can also transfer and withdraw money.

- ❑ *A checking account*
- ❑ *A savings account*
- ❑ *A certificate of deposit*
- ❑ *No idea*

(Answer: A checking account)

With a loan with constant capital repayments...

- ❑ *You pay off a fixed part of the capital every period, the interest you pay does vary every period.*
- ❑ *You pay each period the same amount of capital and the same amount of interest.*
- ❑ *You pay the same amount of interest every period, but the capital you repay varies every period.*
- ❑ *No idea*

(Answer: You pay off a fixed part of the capital every period, the interest you pay does vary every period)

Items relating to the category 'Spillovers'

If you are investing in a basket of shares of several companies, the risk is ..... than if you invest in shares of just one company.

- ❑ *Higher*

- ❑ *Equal*
- ❑ *Lower*
- ❑ *No idea*

(Answer: Lower)

Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money on this account?

- ❑ *Less than today*
- ❑ *Exactly the same*
- ❑ *More than today*
- ❑ *No idea*

(Answer: Less than today)

If you buy a share of a company ...

- ❑ *Then you become partly co-owner of that company.*
- ❑ *Then you provide a loan to that company.*
- ❑ *Then you receive favorable conditions on the products or services that this company sells.*
- ❑ *No idea*

(Answer: Then you become partly co-owner of that company)

Which of the following insurances is legally compulsory?

- ❑ *Hospitalization insurance*
- ❑ *Hospitalization and car insurance*
- ❑ *Car insurance*
- ❑ *No idea*

(Answer: Car insurance)

What is the first thing to do if your wallet with a bank card in it has been stolen?

- ❑ *You wait until money is withdrawn from your account. If so, submit a complaint to the police.*
- ❑ *You immediately call card stop to have your bank card blocked.*

- ❑ *Nothing, because they don't know your secret code anyway.*
- ❑ *No idea*

(Answer: You immediately call card stop to have your bank card blocked)

Which of the following investments has on average the highest risk?

- ❑ *Shares*
- ❑ *Bonds*
- ❑ *Savings accounts*
- ❑ *No idea*

(Answer: Shares)

You receive an e-mail with your bank as sender and with the message to check and complete your personal details. To do this, you must fill in a form asking for your account number and your secret code for internet banking. You must return this form by mail. What do you do?

- ❑ *You fill in the form and send it by e-mail.*
- ❑ *You check if the e-mail contains a virus.*
- ❑ *You do not respond to the e-mail but you may contact your bank.*
- ❑ *No idea*

(Answer: You do not respond to the e-mail but you may contact your bank)

Endnotes

[i] OECD also points to the potential spillover effects to other household members and the larger community. An interesting case in point is the National Strategy for Financial Education (ENEF) financial education project in Brazil covering 868 public high schools and approximately 20 000 students. Zia (2013) reported important spillover effects for the students that participated in the sense that parents' financial knowledge improved. In addition parents also showed more positive financial behaviours like keeping household budgets and increased saving rates.

[ii] The details are beyond the scope of this article, but overall we can state that financial mathematics is included or excluded from the curriculum for the third degree of secondary education depending on the specific competent authority and prevalent educational model. If included, both mandatory and non-mandatory scenarios are found. For details, see De Win (2015).

[iii] Given that unreported results reveal no differences depending on the educational type followed by the students or the school that they attend, we do not report separate results for subgroups based on these characteristics.

[iv] One-way ANOVA analysis to test that the null hypothesis that the effect of financial algebra on the three categories is identical has a p-value of <0.001. The post-hoc Tukey HSD-test for 'Methods' and 'Concepts' has a p-value of 0.002 and <0.001, respectively.

[v] Hence, multivariate analyses where these variables are included as control variables are not conducted.

[vi] Only 4 of them (6.55%) do not pass the posttest.