

Mathematics education and financial literacy: A valued but vulnerable symbiosis

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In England the development of financial literacy and related applications features in several aspects of the intended curriculum, including, but not primarily, mathematics. We argue that the development of key mathematical concepts and of financial literacy have historically often been symbiotic and this inter-dependency is reflected in many curriculum materials. This paper draws on cross-phase classroom-close evidence collected as part of a larger study, to report changes to the preparedness of some learners for engagement with related concepts. Subsequent student and teacher interviews suggested such changes were due to both changing patterns of family life and moves towards virtual, rather than physical, currency in many communities. We discuss the significant implications for organisation of both mathematics and financial literacy curricula, and suggest some ways forward.

Keywords: financial literacy; mathematics curriculum; virtual currency

Introduction

In modern economies, the population's financial literacy is arguably a key feature of successful participation in economic and social life, and poor financial competence can lead to significant social and personal stresses (e.g. Geurin, 2012). OECD PISA outcomes (2017) have shown that there is no clear advantage to discrete financial literacy lessons – but that there is a high correlation between 15-year-olds' performance on financial literacy items, with that on mathematics literacy items. In England, the national curriculum (enacted from September 2014) organises financial literacy education as a key part of personal, social and health education, but elements are also targeted via the mathematics curriculum (DfE, 2013).

Such an approach is well-established in many jurisdictions (OECD, 2017), and serves to give contextual meaning to such mathematical concepts as dealing with decimals, proportional reasoning, exponential growth, representation in and interpretation of graphs, ... arguably providing both motivation to students and supporting transfer of mathematical ideas to contexts commonly encountered in everyday life as young people mature (Brenner, 1998). However, that depends also on students' grasp of underlying related financial concepts such as money as exchange, 'change', unit pricing, budgeting, compound interest ... In this paper, we draw on data from a larger longitudinal study that shows that the intended mathematics curriculum, and well-respected curriculum resources, assume students will bring such financial concepts with them, but that in at least some classes, a significant proportion of the students do not in fact do so. We analyse the impact this has on their access to the intended mathematics learning, and we draw on classroom observations and student interviews to probe students' personal experiences with informal financial education and their perceptions of the normative ways young people and adults deal with financial issues and transactions. The findings contribute a challenge to

assumptions in current mathematics curricula, as well as in basic financial education, for some young people. We argue that the demonstrated disjunctures are likely to be exacerbated over time, to the cost of both mathematical and financial literacy, unless actively addressed by a range of policymakers, and ultimately, by wider society.

Literature review

Development of the 2014 national curriculum in England cited evidence of widespread persistent debt, poor domestic financial management, low levels of savings including for pensions, as rationale for addressing a formal component of financial literacy within citizenship education for students aged 11-16 (DfE, 2013), though in many English schools the national curriculum is non-mandatory. The 2014 mathematics curriculum complements this, nominally to ‘ensure that young people leave school with an understanding of the skills needed for personal finance’ (DfE, 2013, p.3). However, a later influential report (APPG on Financial Education for Young People, 2016, p.8) concluded that financial education in England remained “patchy, inconsistent and varying in effectiveness,” and made recommendations that included strengthening of the requirements within statutory curricula: a better focus on real-life contexts, and extension to within mathematics at primary level. Such additional formal requirements have not yet been introduced, though both primary and secondary common mathematics curriculum resources include some such material. Since 2016, stakeholders have produced a variety of open-source curriculum resources, available to schools for different ages, though there is to date little evidence of their systemic effectiveness.

Globally, there are similar concerns, including which routes best lead to effective financial literacy. For example, Geurin (2012) shows that much more than knowledge is needed to impact behaviour, and that debt, interest rates, repayment obligation, and even financial planning are very dependent on values, emotions and contextual norms; Kaiser & Menkhoff (2017) in their review of such literature conclude that financial literacy is harder to achieve in low resource individual or economy contexts, or if mandatory: education at a ‘teachable moment’ appears to be key. OECD (2017) in their second (PISA 2015) assessment of the financial literacy of 15-year-olds showed the scale of the challenge: one in four participating students (from 15 developed economies) were unable to make even simple decisions on everyday spending, while only one in ten could understand complex issues, such as income tax. PISA 2015 also showed that students who did well in financial literacy were also likely to perform well in the PISA reading and mathematics assessments (especially in China, Singapore). However ~38% of the financial literacy score reflected factors unique to financial skills, and national performance showed negligible correlation with formal financial literacy education. It did, concerningly, generally show a strong link with socio-economic status.

Internationally, financial contexts have been key in giving meaning to mathematical ideas for many years – and there has been symbiotic development of financial literacy (Brenner, 1998). At primary school, for example, notions of equivalence of different ways of making 20p, ‘total cost’ of items, ‘change from 50p’, meaning for decimals with 2 decimal places, have been used to support development of concepts in basic number, and have conversely strengthened financial concepts. At secondary school, building on those to engage with ‘sale prices’ (decimals, %), ‘best buys’ (unit ‘cost’, ratio), mobile phone or energy tariffs as non-proportional, compound vs simple interest on savings as examples of arithmetic vs geometric

growth, exposure to graphs representing many of these ideas have similarly both supported mathematical developments and been supported by them. This paper analyses data which suggest that symbiosis even at a fairly basic level might now be crumbling in some places, with costs to both mathematics and financial literacy.

The study

We draw on initially serendipitous data from a large-scale longitudinal study focused on enactment of the 2014 mathematics national curriculum from age 5 to 16, including impact on learning, and student and teacher use of curriculum and assessment resources to achieve that. It is reported in depth elsewhere (Golding, under review). That study used at least termly contacts over at least two years for each age group: teacher and student interviews, lesson observations, discussions and surveys, documentary analysis and attainment progression data. Altogether, it drew on voices from ~400 teachers, ~4100 students, nearly 200 schools/colleges, and full lesson observations of/data from ~350 classes. Below, we detail two excerpts from study lesson observations planned by teachers to include a focus on problem-solving. Each raises significant questions about the viability in England of current approaches to the mathematics/financial literacy nexus within mathematics education.

Observation 1 was of a year 3 class (7-8 year olds in England) using plastic coins to model transactions and tasks that included ‘finding total cost’, ‘giving change’, and working out different ways to ‘pay for things’. The associated resources were apparently clearly structured, imaginative, and showed careful mathematical progression. Initial whole-class teaching of the lesson was confident, dialogic and apparently inclusive. However, when children then moved to small group or paired independent work, about half the class showed little familiarity with the use of coins for exchange, let alone recognition of common coins. The same children exhibited limited concept of the ‘equivalence’ of different combinations of coins, or notion of ‘change’ in monetary transaction, so they were able to make little sense of the related questions, relying heavily on peers for pathways to an answer.

In a post lesson focus group with six children of mixed mathematical prior attainment, learners reported a wide range of different background money experiences with their families, ranging from those who said they never went shopping from home, through those who regularly went shopping with mum or dad but whose parents always paid, whether by cash or card, to those who regularly played ‘Monopoly’ (“sometimes it takes a very long time, but you can get really rich!”).

The class teacher had listened in to the focus group and recalled in interview that “many years ago, we had a shop in classrooms for years 1 to 4”, but “that had become squeezed out by accountability pressures”. She reported ‘having had her eyes opened’ by listening to children’s accounts of their different background experiences with money (“I couldn’t work out why the usual bright bunnies weren’t getting it”).

Observation 2 was of a year 10 class (15-16 year olds). The initial focus was on taxation as a context for the intended development of use of algebra in spreadsheets. The teacher introduced an initial class discussion, in which it transpired no student received regular pocket money or earned other regular income: some said they were “too busy with homework”. Just one possessed a savings account, for which she’d lost the card; students reported that if they went shopping they’d either ‘be given’ money as they left, or if out with parents the parents would pay – usually by card. Accounts

suggested none was regularly involved in shopping for food or other staples, but some shopped via internet using a parent's card.

The teacher, in interview saying she was "somewhat challenged by these revelations", went on to show a spreadsheet featuring her own gross income, the deduction of tax and other central payments, and her main items of expenditure. She led discussion around meaning and scale of each entry. These mid-teenagers showed no familiarity with the concept of taxes (received as 'a rip-off') or of mortgage payments or similar. "How", the teacher later asked us, "are such young people going to learn to manage their finances when they leave home in three years' time?"

The issues emerging from these observations were tangential to our main study, but we, and the funder, considered them important, and wanted to know how widespread they might be. We acquired additional ethical approval, so as to where possible then incorporate related questions in subsequent school visits. This resulted in additional data from 40 primary teachers and 35 secondary teachers across a total of 35 schools. Our sample for this supplementary work was thus small, drawn from contexts of mixed socio-economic status and teachers already participating in our main study. *We asked teachers*

- (i) to describe recent experiences of working with financial situations within mathematics. We probed both the resources used and the financial experiences and knowledge brought to that by students, asking about variation within that.
- (ii) whether student preparedness had been stable over recent years; if not, any obvious reasons, and the perceived impact on students' mathematics learning.
- (iii) what role mathematics lessons played in their school's overall approach to financial literacy education.

This additional small sub-study did not draw on student voice directly, and there is no claim that the sample is representative for the focus purposes. Analysis of data was by research question and sub-question, using NVivo for initial analysis, then for identifying emergent grounded themes (Charmaz, 2014), as reported below.

Findings and discussion

The study focus curriculum materials, widely used in England, continue an English mathematics education tradition of making full use of financial contexts for the development of mathematical concepts such as those suggested above. Further, in developments for the new (post-2014) curriculum, resources now use many more problem-solving or mathematical reasoning tasks within such contexts.

Primary teachers reported very variable experiences, often related to local family and area lifestyles, with some communities still making daily use of local markets and of cash, and other areas, particularly those with high rates of dual career families, often doing very little basic shopping locally. More experienced teachers widely claimed not to have reflected on the issue previously, but reported that often, children were finding money contexts more difficult than in teachers' earlier experience, and in-class use of those for building mathematical concepts, had therefore become more constrained. Shop play in school, including in reception, was reported now unusual, although teachers had commonly previously used 'shops' for semi-structured play in lower primary years.

Their informal further reflections centred around shrinking local use of small-scale, especially cash, transactions conducted at a child-pace, in time-pressured families; growing use of cards for local purchases; and of course expanding use of online purchases. Such habits make it difficult for young children to build up basic

concepts around money. Some also reflected that pre-school toys sometimes feature ‘card-friendly tills’ that mimic adult actions but with little meaning, school dinner money and other school financial practices have changed, and even child-friendly money apps tend to start with numbers featuring two decimal places, offer no easy model of physical exchange, and are very abstract compared with coins.

Secondary teachers also offered very varied accounts, with much of the variation being between schools (and so, apparently, areas). Some reported students apparently very familiar and confident with handling money (cash and/or virtual), usually correlated with evidence of students typically being given responsibility by parents for regularly selecting and making non-peripheral purchases. These teachers reported that financial and mathematical concepts continued to develop symbiotically.

Other teachers reported that use of financial contexts was “hard work” because of their students’ apparent lack of familiarity with the related financial concepts – including of savings, of interest – and often, of ‘budgeting’. When probed, these teachers typically claimed to give superficial attention in lessons to those contexts per se if students did not appear to be familiar with them, but in discussion recognised some loss of mathematical meaning-making because they were not in a position to make fuller use of financial context. It was unusual for a mathematics teacher to show an overt sense of responsibility for educating students for the related financial ideas.

Few secondary mathematics teachers appeared to be aware of systematic in-school treatment of financial literacy: they simply did not know what financial literacy education their students were receiving beyond their mathematics lessons. Further, with only a few exceptions they were unable to make a clear connection between students’ apparent financial literacy and their socio-economic background. About half of the secondary teachers interviewed identified a clear change (decrease) in at least some students’ financial preparedness to engage with related mathematical ideas over recent years, usually linking that with changing social patterns of using and taking responsibility for money, but few appeared to have related that to possible wider levels of financial literacy.

Finally, a small number of teachers in 11-18 schools pointed to the post-16 ‘Core Maths’ courses as instrumental in supporting in-depth, mathematically-informed, engagement with financial ideas, at a time when students were beginning to think about organising personal finances for living away from home, and so a ‘teachable moment’ (Kaiser & Menkhoff, 2017). Two others pointed to Scotland’s recently-introduced ‘Personal Finance’ awards as an alternative low-stakes approach.

Conclusions

This small study offers clear indications that teachers of mathematics in all phases, need renewed sensitivity to, and consideration in their mathematics planning, of, the money-related experiences their children are bringing to school, and to both build up and use those appropriately. They cannot assume that children bring notions of the exchange of money for goods, equivalence of different coin combinations, ‘change’, or of making choices according to the money available, nor that at a later stage, young people will bring a functioning grasp of savings, budgeting or debt-related issues. Where they do not, and they appear to vary within and across communities, there are significant implications for students’ mathematics learning (Brenner, 1998), as well as for the building of an informed and financially responsible society. We would argue such issues need proactive addressing at a whole-school level from pre-school onwards, perhaps through the use of existing open source resources and/or post-16

low-stakes qualifications. Because of local variation, they need local knowledge to select from appropriate resources to meet curriculum intentions.

There are implications too for financial literacy education: children's basic financial literacy can no longer be assumed to rest on everyday experiences with cash, that build up core ideas of 'exchange' 'equivalence', basic budgeting and choices. Some families involve young people in plastic or internet-based transactions, or support children in coming to use their own online account, but such experiences are more abstract than dealing with coins, so need different and later support. Other children use cash from a young age, perhaps moving also to digital transactions. Some young people, though, have very little interaction with, or understanding of, financial transactions or decisions, even into their mid-teens, and this study shows the deficit is not in England confined to those from low socio-economic backgrounds.

While schools and colleges have a part to play, healthy financial practices do not have a simple relationship with financial literacy education, whether in or beyond mathematics lessons (OECD 2017), but are often engrained in family and community practices (Geurin, 2012). There is therefore a need for related issues to be effectively and coherently addressed at both a public action and an education policy level.

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