

Context counts: The potential of realistic problems to expose and extend social and mathematical understandings

Carly Sawatzki

Monash University

<Carly.Sawatzki@monash.edu >

This article reports the findings of research involving more than 30 teachers and their Year 5 and 6 students in 16 Victorian primary schools. The participants experienced an educational intervention where the “Money and Financial Mathematics” substrand of the “Number and Algebra” content strand was taught and learned through challenging worded mathematical problems involving realistic financial contexts. Data related to one such example, a task involving three friends sharing the cost of movie tickets and food, are discussed. Insights into the nature of student

This article explores the outcomes of financial literacy education in Australia, and the potential of challenging worded mathematical problems involving realistic financial contexts to connect students’ social and mathematical understandings. In 2012, the Organisation for Economic Cooperation and Development (OECD) Programme for International Student Assessment (PISA) included a Financial Literacy Assessment for 15-year-old students. While media reports have been congratulatory, emphasising that Australia ranked in the top five of 18 participating countries, a strong relationship between student socioeconomic background and performance was evident (Thomson, 2014). Students in metropolitan schools achieved more highly than students in provincial and remote schools; and non-Indigenous students significantly out-performed their Indigenous counterparts (Thomson, 2014). Essentially, financial literacy is no different from numeracy or literacy where disparities in educational achievement are associated with socioeconomic marginalisation (Snyder & Nieuwenhuysen, 2010). While the results point to effective financial literacy education taking place in some contexts more so than others, there is limited Australian research what might be done to improve outcomes for students in marginalised communities. Furthermore, consumer, economic, and financial socialisation research together with behavioural economics research build a compelling case that human financial behaviour may depend as much on intrinsic psychological attributes and social understandings learned at home as knowledge and skills acquired at school (de Meza, Irlenbusch, & Reyniers, July 2008).

Ajzen’s (1991) theory of planned behaviour provided a theoretical framework to explore this proposition. The theory of planned behaviour argues that *attitudes*, *subjective norms* (expectations or perceived social pressure from socialising agents including parents and teachers), and *perceived behavioural control* (resources, opportunities, and confidence) have a direct effect on intentions and an indirect effect on behaviour through intentions. Since *values* also seem to be important to the formation and development of attitudinal and behavioural tendencies (Homer & Kahle, 1988), the possibility that they too might contribute to students’ financial problem-solving and decision-making was considered. *Values* are understood to mean “...the principles and fundamental convictions which act as general guides to behaviour, the standards by which particular actions are judged as good or desirable” (Halstead & Taylor, 2000, p.169). Later, I describe how these definitions guided the data collection and analysis.

There were three assumptions. The first was that financial problem-solving and decision-making would be indicative of financial behaviour. The second was that

classroom research examining the impact of *attitudes*, *subjective norms*, *perceived behavioural control*, and *values* on students' responses to mathematical problems situated in realistic financial contexts might give insights into the social and mathematical dimensions of student financial literacy. The third was that these insights might inform how financial literacy is conceptualised, taught and learned at school.

The Encouraging Persistence Maintaining Challenge (EPMC) project involved an educational intervention featuring five challenging mathematical problems situated in realistic financial contexts – termed “financial dilemmas” - as the basis of money and financial mathematics lessons. Financial dilemmas are open-ended, require students to draw on both social and mathematical understandings simultaneously and in synergy, involve multiple solutions, and invite students to share and explain their reasoning. Importantly, the tasks involve situations that 10-12 year old children might be familiar with and/or interested in and/or able to imagine. They are “realistic” in the sense that they feature practical, applied and contextual mathematics. The financial dilemmas were intended to be used together with the following researched pedagogies and practices that have been argued to enhance mathematics learning:

- Establishing the relevance of the task to everyday life beyond school (Mandell & Klein, 2007) and explaining the importance of both social and mathematical thinking to informed financial problem-solving and decision-making.
- Building a strong lesson introduction through literacy and other strategies that give students confidence to begin problem-solving (Draper, 2002). Strategies that seem to be particularly helpful to students include the use of role play and concrete materials (i.e., notes and coins).
- Emphasising problem-solving tools and strategies that might help students, including creating tables to organise information and/or drawing pictures (Goos, Dole, & Geiger, 2011).
- Providing time for individual thinking and problem-solving, followed by small group collaboration where students can share and discuss their problem solving approaches and solution/s (Smith & Stein, 2011).
- Facilitating critical whole-class discussions, including: all the while ensuring that a range of options (mathematical workings and explanations) are recorded, and open, sometimes provocative questions are asked to stimulate different ways of thinking (Walker, 2014).

The research question is: What insights into the social and mathematical dimensions of student financial literacy can be gained from using financial dilemmas for mathematics teaching and learning?

Some Relevant Prior Research

The following literature provided insights that shaped the snapshot of the EPMC project reported in this article. Various researchers have explored the use of worded mathematical problems involving realistic contexts and have argued the potential for these to: enhance student motivation (Middleton, 1995); provide opportunities to apply mathematical knowledge and skills (Verschaffel, deCorte, & Lasure, 1994); engage students in productive exploration of mathematics (Christiansen & Walther, 1986); provide students with opportunities to develop deeper and stronger mathematical understandings (Zbiek & Conner, 2006); and help students to see the relevance and importance of mathematics beyond school (Sullivan, 2011). These outcomes are desirable in that they contribute to educating functionally numerate citizens. Students need to be able to apply

mathematics to a variety of contexts, whether in the classroom, on standardised assessments, or in the ultimate “high stakes” test – everyday life beyond school.

However, finding meaningful contexts in which to situate mathematics teaching and learning can be difficult. Borasi (1986) emphasised that students are the ultimate judge whether a problem is appealing enough to attempt to solve it, and they make this judgement based on the level of difficulty they perceive in the problem, their interest in it, and the importance they ascribe to it. Meyer, Dekker, and Querelle (2001) outlined a number of characteristics of high quality contexts, which included that a context should: support the mathematics and not overwhelm it; be real or at least imaginable; be varied; relate to real problems to solve; be sensitive to cultural, gender and racial norms; not exclude any group of students; and allow the making of models. However, they agreed with Borasi (1986) that a context that interests and motivates one student might hold no interest for another.

Stillman (2000) investigated the impact of prior knowledge of context on senior secondary students’ approaches to application tasks. She classified three sources of prior knowledge: academic knowledge; general knowledge of the world; and episodic knowledge derived from personal experiences outside school or in practical school subjects. Stillman (2000) found that episodic or experiential knowledge is particularly influential in shaping the extent to which students may engage with a task context. Jorgensen and Sullivan (2010) have also written about this phenomenon, drawing on their experiences in remote Aboriginal settings. They highlighted ways by which social heritage converts to academic success, giving specific examples of items about money that were included on the 2008 Australian numeracy assessment. They argued that while particular contexts may be realistic for some students, they are well outside the everyday experiences of others, and so create opportunities for ‘scholastic mortality’ among those who are already disadvantaged (Jorgensen & Sullivan, 2010).

Realistic Mathematics Education (RME) in The Netherlands provides an example of how mathematics teaching and learning can be conceptualised. RME is based on the view that mathematics “must be connected to reality, stay close to children and should be relevant to society” in order to be of human value (Freudenthal, 1977 in van den Heuvel-Panhuizen, 2003, p.9). RME proposes that the imagination can serve to enhance task authenticity. This suggests that students who do not have what Stillman (2010) describes as episodic or experiential knowledge related to a context can still access unfamiliar or novel task contexts provided pedagogies that help them visualise the context are used.

On one hand, the above perspectives underline the importance of taking into consideration different understandings about money students bring to school from home based on their financial realities, and situating teaching and learning in realistic contexts that connect with students’ experiences. On the other hand, if schooling is to redress the apparent disparity in financial literacy levels associated with socioeconomic background, there is merit in posing contexts that are at least imaginable and perhaps might expand students’ experiences. The educational intervention intended to use realistic financial contexts as the key to strengthening students’ disposition to connect social and mathematical thinking as part of their financial problem-solving, the assumption being that doing so would likely contribute to informed financial decision-making.

Methodology and Methods

The EPMC project is an example of a design-based research (DBR) project. Anderson and Shattuck (2012) draw on a range of definitions of DBR to explain it as:

- being situated in a real educational context;
- focusing on the design and testing of a significant intervention;
- using mixed-methods;
- involving multiple iterations;
- involving a collaborative partnership between researchers and practitioners; and
- promoting design principles that have an impact on practice.

DBR has become recognised as a valuable methodological approach to study, transform and evaluate the practice of mathematics teaching and learning. It is a practical research methodology that seeks to increase the impact, transfer, and translation of educational research into improved teacher practice (Anderson & Shattuck, 2012).

A series of classroom investigations took place to study the implementation of the five financial dilemmas that were included in the EPMC project (the educational intervention). Each financial dilemma included enabling, consolidating, and extending versions (Sullivan, Mousley, & Jorgensen, 2009). This article reports on data collected about one financial dilemma, “Anna and her friends”, which involves three friends sharing the cost of movie tickets and food. The classroom investigation explored the use of this task by two experienced educators (pseudonyms Cara and Cate) team-teaching 55 Year 6 students in an open learning environment in a government school in provincial Victoria. The teachers described their students as being from diverse socioeconomic backgrounds. Data collected included audio and video recordings of the instructional and summary phases of the lesson, hand-written observational notes made by two researchers, and students’ completed worksheets.

Post-intervention surveys were also completed online by more than 30 Year 5 and 6 teachers in 16 Victorian primary schools. The sample included teachers from Government and Catholic, metropolitan and regional primary schools. The teacher participants were asked to respond to a series of brief statements by indicating the extent to which they agreed on a 5-point Likert scale (strongly disagree, disagree, unsure, agree, strongly agree). The statements related to financial literacy education (in general), lesson planning, lesson structure, and pedagogies. For each of the five financial dilemmas, there were a further 10 brief statements that required the teacher participants to reflect upon the effectiveness of the tasks as the basis of money and financial mathematics lessons. The teachers were also invited to give feedback about the tasks and pedagogies through five open-ended questions. Responses to two particular questions with reference to “Anna and her friends” - “What is your reaction to the lesson overall?” and, “Is there a particular story you would like to share with us?” – are reported in this article.

Drawing on the theoretical model described earlier, the classroom investigation and post-intervention survey data were analysed and categorised as indicating *attitudes*, *subjective norms*, *perceived behavioural control*, and *values* (as per the definitions outlined earlier). This process was undertaken with a view to understanding the nature of the social understandings that became evident through the use of “Anna and her friends”, and describing how these seemed to impact the way students connected with the mathematical dimensions of the task. For example, where data reflected a particular ideal, these data were interpreted to indicate a *value*. Where patterns of behaviour became apparent, it was inferred that *subjective norms* were influential. Scrutinising the data sources with EPMC project colleagues helped to ensure validation. In the section that follows, synergies between the data sets are examined to seek insights into the social and mathematical dimensions of financial literacy.

“Anna and her friends” was presented as follows:

Task 1:

Anna, Bernadette and Carol are going to the movies together. Tickets cost \$12 each, but there is a special offer for everyone who books and pays online - buy two tickets, get the third ticket free. Anna booked and paid for the tickets online.

When they arrived at the theatre, they noticed the pricelist at the shop. The price list reads as follows:

Bottled Water	\$4
Icecream	\$4
Medium Popcorn	\$8
Bottled Water, icecream & popcorn combo	\$12

Anna wants to buy a bottle of water, Bernadette wants the ice-cream and Carol wants the popcorn. Anna pays for the combo.

What might Anna say to Bernadette and Carol about how much they owe her?

Task 2:

This version of the task requires students work in dollars and cents, and account for an online processing fee of 30c per ticket purchased.

This task was considered relatable to Year 5 and 6 students since children this age are likely to have visited the cinemas before, and may have been responsible for paying for their transactions upon doing so. In Task 1 (the learning task), the calculations required were intended to be straightforward for Year 5 and 6 students, compared with Task 2 (the consolidating task) where students work in dollars and cents, and account for an online processing fee of 30c per ticket purchased. In both scenarios, notions of friendship and “fairness” – described as social understandings - are important considerations. There are multiple ways to approach this financial dilemma, which is critical for creating an awareness of alternative possibilities, and fostering critical whole-class discussion and debate about financial problem-solving and decision-making. Readers are invited to tackle these tasks before proceeding.

Findings

In the classroom investigation, two important issues emerged that were reinforced by the post-intervention survey responses by the broader group of teacher participants. First, the task involving a realistic financial context that 10-12 year old children might be familiar with and/or interested in and/or able to imagine seemed to contribute to students being actively engaged in the lesson. Second, “Anna and her friends” revealed that Year 5 and 6 students have sophisticated social understandings about money that are at the forefront of their thinking during financial problem-solving and decision-making. Each of these findings is elaborated below.

The Importance of the Choice of Context and the Lesson Introduction

“Anna and her friends” involving a realistic financial context that 10-12 year old children might be familiar with and/or interested in and/or able to imagine seemed to contribute to the success of the lesson. The following comment reflects the view of many of the teacher participants:

The kids had all been to the movies, so were able to relate to this task. They were also getting used to discussing deals, value for money, and “fair share”.

Interestingly, context familiarity was not assumed or taken for granted in the lesson by Cara and Cate. This is important, since attending the movies as entertainment is beyond the realms of affordability for some students. In launching the lesson, they set up an impromptu role play involving three classmates in the roles of Anna, Bernadette, and

Carol. The students, in role as the characters, casually conversed about how much each person should pay towards the movie tickets and combo. This worked well to showcase two different approaches to sharing the cost. The student playing the role of Anna said, “I got my ticket for free. So if you pay me for your tickets, I’ll pay for the combo.” The student playing the role of Bernadette had another idea, “I think we should split the cost of the movie tickets - \$8 each – and then pay for our own share of the combo. Carol will have to pay \$2 more because the popcorn is worth a little more.” Inherent in this brief exchange were different *attitudes* and *values* about sharing costs. Cara and Cate’s pedagogical choice to use role play seemed to activate students’ imaginations and make the task more accessible to the class.

Social Understandings are at the Forefront of Students’ Financial Problem-Solving and Decision-Making

When it came to distributing the costs of the movie tickets and food, students preferred to equate “fairness” with sharing equally, at least in the first instance. On the post-intervention survey, one teacher described this approach as “taking the easy option”. Related to this, another commented that some students “were keen to get a maths answer without justifying their thinking” in relation to the context. This phenomenon suggests that students were initially motivated by a perceived need to adhere to a particular *subjective norm* – a social convention that “fair” means sharing equally. Furthermore, this motivation influenced their choice of mathematics.

As the following comments by two different teachers reveal, the teachers reported provoking or extending their students to revisit and discuss the complexities of the context:

The students were engaged, but most were happy to split the [cost] evenly. As the teacher, I needed to get the conversation moving by throwing in a few controversial ideas.

They didn’t realise the popcorn was worth more than the water and ice-cream. They wanted to split the cost three ways - \$12 each. I questioned them, “Is that fair?”

In these ways, pedagogy was pivotal to stimulating new learning. In the classroom investigation, Cara and Cate encouraged students to debate the idea that costs can be shared equally (or “evenly” – the term interchangeably used by teacher participants) or proportional to the value of items to be received. They asked students to consider, “Is sharing evenly always the fairest thing to do? Is it fair to split the cost of the combo evenly given that Carol will receive the most valuable item (popcorn)?” These questions were addressed nicely by one student, who tabulated two different solutions how much Bernadette and Carol owed Anna, as shown in Figure 1. One solution is described as “Equal,” the other as “Fair”.

On the post-intervention survey, one teacher outlined students’ diverse *values* and responses to this problem saying, “Some strongly believed that Anna should have benefited from the discount/saving, while others believed she should have [paid for] her friends”. These examples highlight how *values* can influence students to take different mathematical approaches to financial problem-solving and decision-making: if Anna retains the free movie ticket and the cost of the food is shared equally, she pays as little as \$4 for the outing compared with Bernadette and Carol who pay \$16 each. By contrast, if Anna pays for herself and her friends, she spends as much as \$36.

In the classroom investigation, the ideas students contributed to whole class discussion and recorded on their worksheets demonstrated sophisticated social understandings about money. During Cara and Cate’s lesson, one student explained to the class that Anna should receive the free ticket but pay for the online processing fee and combo. He justified his

thinking that Anna should pay slightly less than her friends (\$10.90 compared with \$13.50) by saying, “Paying this makes it fair in the sense that Anna did all the work.” Other students also made reference to perceived social conventions (*subjective norms*). For example, one wrote, “If they were really good friends and went to the movies often, then they could just take it in turns paying the total price.” Another seemed to see the opportunity for Anna to conceal the free ticket from her friends, noting on her worksheet, “I think that it really depends on how good [a] friends they are because if Anna booked the tickets online and paid for them she could have the free ticket and the two others would pay \$12 each.” In each of the above-mentioned options, students *valued* and were motivated by different notions of friendship and “fairness”.

Name:	Equal	fair
Carol	\$12	\$14
Anna	\$12	\$11
Bernadette	\$12	\$11

Equal- \$12 each because anna and bernadette pay \$12 for tickets and carol pays for combo.

Fair - Carol pays \$2 more because she wants the more expensive things. So there for she has to pay \$2 more

Figure 1. Student worksheet: The difference between equal and fair.

Since financial dilemmas involve multiple solutions, the onus is on students to produce and defend an argument that is socially acceptable / “fair” and mathematically precise. Requiring students to draw on their social and mathematical understandings simultaneously and in synergy when explaining an argument revealed what *attitudes*, *subjective norms* (expectations), and *values* about money were motivating students. These factors could then be considered as part of critical whole-class discussion aimed at promoting more informed financial problem-solving and decision-making.

Conclusion

The findings reveal insights that might inform the way financial literacy is conceptualised, taught, and learned at school. “Anna and her friends” exposed that Year 5 and 6 students have sophisticated social understandings about money that, when set against realistic financial contexts, can be productively leveraged to facilitate engaging money and financial mathematics lessons. While social understandings such as *attitudes*, *values* and *subjective norms* seem to be at the forefront of students’ thinking during financial problem-solving and decision-making, particular pedagogies and practices including role play and open, if not provocative questions posed by the teachers during critical whole-class discussion can help students identify and evaluate alternative ways that costs might be shared. In this way, the educational intervention served to strengthen students’ disposition to connect social and mathematical thinking and, by extension, make more informed financial decisions.

The critical implication is that while financial dilemmas appeal to what Stillman (2000) describes as students’ episodic knowledge, posing contexts that are at least imaginable can expand students’ experiences as well as their toolkit of social and mathematical

understandings. Financial dilemmas do not “stand alone” – their power lies in the associated pedagogies and practices that bring them to life. If teachers are to create and/or select realistic but perhaps unfamiliar or novel financial contexts as the basis of money and financial mathematics lessons, they need to know their students’ family backgrounds, characteristics, and interests. Broader and successful implementation of the educational intervention will rely on further research of this nature, whereby new financial dilemmas are developed, trialled, studied and refined in collaboration with teachers. Professional learning opportunities designed to build teachers’ capacity to use the associated pedagogies and practices with confidence will be critical. Such research is currently underway in Indigenous, rural and remote communities.

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