The Mathematics in Children's Out-of-School Economic Activity

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We report a study designed to investigate children's out-of-school economic activities, with a focus on the mathematical thinking that these involve. Children in Year 5 (9-10 years old) and Year 8 (12-13 years old) participated in a series of activities over two weeks, which involved the documentation of out-of-school activities. These included a structured diary, a photo-taking activity, and a questionnaire for parents to complete. Groups of 3-4 children were then interviewed in order to understand and explore the activities represented in these documents. We will present two main findings from our ongoing analysis. The first is that children are engaged in a rich range of mathematical practices. The second is related to differences in the language that children use to talk about out-of-school mathematics and classroom mathematics, and ways in which these differences appear to play a role in inhibiting children's ability to mathematise aspects of their lives outside of school.

Keywords: economics; informal mathematics; out-of-school mathematics

Background

There has been a great deal of coverage in the media regarding school-leavers' lack of basic numeracy. One recent report (BBC, 2012) suggests that 35% of employers are unhappy with young peoples' level of numeracy. On the other hand, GCSE (General Certificate in Secondary Education – an examination taken by English school-leavers at age 16) grades in mathematics have been improving steadily over the past decade. Ian Smith, the chairman of the charity Young Enterprise, was reported as saying, "The situation is getting worse because the Department for Education is adopting an alarmingly narrow focus on academic skills and exams" (Telegraph, 2012). The working hypothesis of this study is broadly aligned with this statement – taking the view that children are leaving school with 'basic numeracy', but without sufficient skills and experience in applying this numeracy to life- or workplace-situations.

Learning Transfer and Funds of Knowledge

The debate of Anderson, Reder and Simon (1996) and Greeno (1997) hinges in part on the question of transfer. Since Carraher, Carraher and Schliemann (1985), there has been a position amongst educational researchers that learning is situated in the context in which it occurs – this position is referred to variously as situated learning, situated cognition and so on. The main finding of Carraher, Carraher and Schliemann (1985) is referred to by both Anderson Reder and Simon. (1996) and Greeno (1997), but both have very different interpretations. Carraher, Carraher and Schliemann (1985) found that Brazilian street vendors could not resolve schooled versions of the arithmetical operations that they mastered on the streets. This and other studies seem to be in line with Situated Learning Theory (e.g. Lave and Wenger, 1991). This claim has been challenged with evidence of the transferability of knowledge across contexts.

Anderson, Reder and Simon (1996) claim that findings such as that of Carraher, Carraher and Schliemann (1985) show only that mathematics that is learned in concrete contexts does not always transfer easily to other contexts.

González, Moll, and Amanti (2005) coined the term 'funds of knowledge' in reference to the knowledge that children gain in their households. Classroom practices often fail to exploit this knowledge, provoking a discontinuity between home numeracy practices and classroom mathematics (Anderson and Gold, 2006). Winter et al. (2004) reports a project focusing on children taking mathematics from school to home and from home to school. In the paper there is a debate about the value of home-to-school compared with school-to-home transitions. They conclude that the home-to-school direction is potentially more valuable, but difficult in the UK due to diversity of home experience. They perceive the UK home and community environment to be more diverse than that observed by Moll and colleagues (Hispanic children in Arizona). However, Winter et al. has a firm focus on 'mathematics' – which may have limited the scope of children's thinking about out-of-school activity. There was also only limited use reported of out-of-school materials and documents in the classroom, which may have restricted some potential value of the home-to-school transition.

Economic Activity

Children as young as six years old understand economic concepts such as supply and demand (Leiser and Beth Halachmi, 2006) and parents actively teach their children to handle money autonomously (Furnham, 2001). Children are capable of developing strategies to make effective economic decisions when saving (Otto et al., 2006). A small number of studies have addressed the link between these forms of economic reasoning and behaviours and children's mathematical thinking. For example, Taylor (2009) and Guberman (2004) focus on arithmetic operations involved in real-life monetary practices.

Children's economic activities are not restricted to handling money, and non-monetary economic activities are also likely to involve mathematical thinking. For example, the exchanging of food in the playground (Nukaga, 2008), the negotiating of labour whilst playing (Webley, 1996) and the collecting of trading cards (Cook, 2001) all involve mathematical thinking. The present study adds to this literature by describing a number of ways in which mathematics might be involved in children's understanding of their economic activity. It investigates children's perceptions of any connection between this informal, out-of-school mathematical thinking and children's experience of classroom mathematics learning. We are working with the motivation that there is evidence that children are engaged in sophisticated activity outside of school that has the potential on which to build formal mathematical thinking.

Method

Participants

Participants were drawn from three schools in the local area, including one secondary school and two primaries. One class (approx 25 children) was selected from each primary school (ages 9 to 10 years, one low SES, one average SES) and 2 classes (ages 12 to 13 years old, one high achievement group, approximately 30 children and one low achievement group, approximately 15 children) from the secondary school.

Materials and Procedure

There were three stages to the data collection for this study, conducted over three weeks. In week one the participants were introduced to the study, and took home a questionnaire for their parents and a diary booklet for recording their economic activities over 1 week. In week two we conducted a self-documentation activity. Children were presented with two sets of cards. One set included six cards of monetary activities: Working, Selling, Borrowing money, Lending money, Spending, and Saving. The other set included five cards of non-monetary activities: Borrowing things, Lending things, Giving gifts, Swapping things and Collecting. Children selected one card of each set (one monetary and one non-monetary) according to what they wanted to, or thought they would be able to, document during the following week. Then we lent them a digital camera and asked them to take pictures to document their chosen activities. Finally, in week three we conducted group interviews where we asked children to talk about their pictures.

In the first part of the interviews, each selected one of his or her pictures and was prompted to talk about it with questions such as 'What's in the picture?', 'Why did you take it?'. Follow-up questions retrieved details about the practices involved in the activity. For example, when the picture showed a monetary activity such as spending, questions addressed issues such as the origins of the money or the amounts of money involved. Children were asked to comment about each other's pictures, in order to search for common or contrasting experiences. In the second part of the interviews children were prompted to talk about mathematics in terms of the concrete situations that they described; for example, explaining how they used mathematics to make decisions about spending or saving money. We also explored the connections between the reported activities and the learning of mathematics in the school.

Results

In this paper we will focus on interview data that illustrates two aspects of the findings. The first relates to the range and nature of activities that were documented during the study. The second relates to the barriers observed between children's out-of-school mathematical practices and their classroom mathematics.

Mathematics in out-of-school economic activity

The economic activities documented during the study can be grouped under five headings: Spending money, Saving, Collecting and Trading (Trading cards), Producing value (making and selling), and Investing.

Spending Money

Children reported spending money on a wide variety of goods and services, the most common being food and drinks, computer games, clothes, and going out with friends. The money for buying these things came from pocket money, occasional money (e.g., birthday) or on-demand money (i.e., just asking for it).

> Understanding of the price-value relationship:
>
> Researcher: what kind of things change the price [of games]?
>
> A: better games cost more
>
> R: Who decides which is a better game?

F: I do…

J: …you lose track of time something like that…

Dealing with choice:

A: [choosing a game] … I got the COD one, because it has Xbox Live

B: [shopping for clothes] I put things in my basket and if I need to I just ask for more money

Saving

Children reported saving that was sometimes supervised – in a bank account opened by a parent, for example – and sometimes autonomous as with a money-box. Saving was both short-term; "…I am saving to get a new Xbox [game]"; and long-term; "I save all my money… I am a very prepared person, I am saving for university".

Children reported that saving is 'hard'.

…I have [a money box] in my bedroom and every time I wake up it is there and I say uh, I want to get some money… (low SES primary school girl)

I am trying to [save for an Ipad], but that's not really going to work (she gets £ 2.50 per week) (high SES primary school girl)

Collecting and Trading

Understanding of demand and offer:

[the cards] keep changing; they want to get more money out of you. Like some years ago there were these cards that were really good and there were loads of them, and then they changed to these new cards and we collected them, and then after about six weeks they changed to another one, and we still have not finished collected the other ones.

Appropriation of the trading norms:

[the value of a card] it kind of evolves, say that I have a really good common, that has Amy Pond, and she has a rare that is rubbish, then we may just swap

Producing Value

Generating means of production with investment and profit (Selling earrings):

S: [how many pairs to sell before profit] … 10 pairs… I figured that out while making… I thought I was going to sell about two pairs, but cannot make just 10 pairs, just in case they all go… I made 45 and sold 35

Working outside house (ordering leaflets):

V: [labour and payment] depends on how well I do, say I just did half of the thing [a rack] it will be about 10p, say one row, but if I do the whole thing I will get £5

Investing

M is a lower ability boy who gets £20 pocket money each week. He collects a range of things, including model cars that he buys on e-bay:

Researcher: Do you play with them?

M: No, they are collectible…. Keep them in the boxes all the time… I will keep them for a bit until I am an old man and sell it

R: Do you do it on your own?

M: No, my mum is doing it with me as well…

> R: how do you know what things will become more expensive in the future?
>
> M: … condition of the box and the car

Barriers between out-of-school maths and classroom maths

After approximately 20 minutes of discussion of the various forms of economic activity documented by participants, the researchers asked the question, "What mathematics do you do outside of school?" The first answer from every group concerned spending money in a shop, as in this answer from a primary school girl:

> "sometimes when I walk home on my own... my mum gives me one pound... and some sweets cost 20p, some 10p some 5... so I have to add them up to make sure I get the right things"

Roughly half of the groups mentioned cooking, as in this answer from a primary school boy, "when I'm making a cake... I have to measure out the flour and things". Three groups mentioned time management, as in this answer from a secondary school boy, "when you have to do something and you don't know how much time you have left...". We also asked participants, "Can you think of any real-life examples that you use in maths classes?" All responses to this question involved shopping – for example, working out how much a collection of items will cost. However, one indicative response, from a primary school boy, was, "we don't do about our personal lives… we do about made-up people".

Language barriers

Participants used very different language for talking about mathematics in the classroom compared with mathematics outside of school. When talking about classroom mathematics, children used the language of curriculum documents and text-books, describing activities with words and phrases including 'percentages', 'estimation', 'weights and measures' and 'adding on'. When talking about maths that takes place outside of school, children did not use the word 'mathematics'. The maths that they spoke about was inseparable from the activity that they were discussing.

Abstract knowledge or concrete application?

During the focus group sessions, participants frequently expressed the want or need for mathematics for their future lives. Children spoke about activities including money and debt management, choosing amongst financial service providers such as for a loan or credit card, and managing bills, including choosing utility providers. However, evidence from exercise books, children's statements and teacher statements suggests that most children, at least in the older age group, have the mathematical skills that they need to do these things effectively. The ability, or possibly the confidence, to apply relatively abstract knowledge (classroom mathematics) to concrete problems out of school appears to be a major difficulty for the participants in this study. This leaves us with the question of exactly what it is that creates the observed barriers between classroom mathematics and out-of-school mathematics? This study suggests that differences in language used for talking about mathematics in different contexts, and children's lack of experience working on unstructured, open-ended, problems in the classroom, both contribute. Further work is needed in order to understand the problem, and to address these difficulties, if children leaving school

are to be equipped with the mathematics that they need to function effectively at home and in the workplace.

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