Economic activity and maths learning: project overview and initial results.

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We present the overview and initial results of a project that explores the links between the out-of-school economic activities of UK children (8 - 16) and their learning of mathematics. The aim is to inform and enhance children's classroom mathematics experience to make it meaningful and engaging, especially for underachievers. Economic activity is interpreted and researched in a broad sense, covering activities around money (e.g., paid work, pocket money, gambling) but also other non-monetary transactions (e.g., swapping, collecting, giving gifts). The project methodology has three stages: A survey of children' seconomic activities, Qualitative studies including diary studies and focus groups and task-based interviews. The initial results of the survey have both similarities and differences with previous studies of children's money usage, and revealed a wide range of economic actitivies in which non-monetary goods are central. Moreover, some of these activities are likely to involve matehmatics more complex than simple arithmetic. These findings are discussed in relation to the anticipated results of the project.

Informal learning, transfer, economic activity, maths learning

Introduction

There has been a debate in the mathematics literature since Carraher, Carraher and Schliemann (1985) regarding the relationship between out-of-school experience and classroom mathematics. This research showed that children (in this case Brazilian street traders) can develop sophisticated strategies in response to arithmetic problems. However, there is evidence to suggest that children are unable to draw upon these strategies when similar problems are presented outside of those children's usual frame of reference. This research, combined with findings from similar studies, has contributed to the development of situated learning theory (e.g., Lave and Wenger 1996), built on the assertion that learning is grounded in the context in which it occurs. In response to the development of situated learning theory, cognitivists have provided evidence that children are in fact able to transfer learning from one context to another (e.g., Anderson, Reder, and Simon 1996). Research has also shown that it is easier for children to transfer learning from abstract to concrete contexts than the reverse (Mevarech and Stern 1997).

Despite the mixed evidence regarding the transferability of informal learning, there is certainly evidence that the incorporation of realistic context in mathematics education can be beneficial for students. For example the Realistic Mathematics Education project (RME, e.g., Gravemeijer 1994) has had great success in improving outcomes of mathematics students in the Nertherlands, by making efforts to ensure that classroom mathematics is made relevant and meaningful to children (not only by incorporating context). The work on RME is related to research on children's responses to word problems (Verschaffel, Greer, and De Corte 2000), showing that

children often fail to take account of context when giving an answer to a word problem.

If there is a consensus to be drawn, then it is likely to be that realistic context is essential for learners, especially low achievers, to become interested and engaged in the curriculum, but that there is no clear understanding at this point regarding the best ways to incorporate realistic context in classroom mathematics. Much of the empirical research that has been done has either looked at what children can do in informal situations that they can't do in formal contexts or the mistakes that children make when working on 'realistic' problems. Very little work has been carried out that actively explores ways in which UK children's out-of-school practice could impact on their mathematics classroom experience. Some recent work has made some headway in this area. Gonzalez, Moll and Amati (2005) use the term 'funds of knowledge' to describe the knowledge students gain from their family and cultural backgrounds. This concept was drawn upon during the Home-School Knowledge Exchange project, part of which involved an investigation of ways in which schools could stimulate the transfer of knowledge both from school to home and from home to school, in order to encourage children's numeracy development (Winter et al. 2004). The project described here aims to build a bridge between the economic psychology literature and research on the relationship between children's mathematics practice in and out of the classroom. The main aim of the project is too explore ways in which the development of such a bridge can contribute in a positive way to children's classroom experience.

Children's economic activity

Children's economic activity has the potential to impact on their experience of classroom mathematics learning. In this project, economic activity is interpreted in a broad sense, encompassing different sorts of transactions (e.g., exchanging, buying, saving) with adults (e.g., parents) and peers (e.g., siblings, friends). There is research about children's usage of pocket money (e.g., Furnham 1999, 2001) and their understanding of economic concepts (e.g., Leiser and Beth Halachmi 2006), but only a small number of studies have studied the mathematics involved in children's economic activities. For instance, Taylor (2009) documented strategies employed by low-income American children during everyday purchasing activities, such as their misuse of whole number when dealing with coins of different value. Similarly, Saxe (1988) described that Brazilian children selling candies on the streets employ strategies such as grouping small numbers into larger units to handle a changing price ratio, and Guberman (2004) reported that children need to compare and count sets and make multidigit operations (e.g., summing and multiplication) in out of school economic activities such as shopping. This is the sort of activities and mathematics that this project aims to discover. However, we want to expand the view of economic activities to include not only monetary transactions, but also activities around non-monetary goods. Moreover, we are not only interested about how children develop an understanding of adults' economy, but also about the conventions and mathematics of their own economies.

Overview of the project

Participants in the research will consist of English primary and secondary school students in three age groups, 8-10, 11-3, and 14-16. These groups fall into each of the three Key Stages in the English National Curriculum (Key Stages 2, 3, 4). The research questions are:

What economic activities do children engage in out of the classroom?
- How does children's engagement in economic activity contribute to their development of economical and mathematical knowledge and concepts?
- How far does children's out of school economic practice correspond with classroom mathematics practice?
- What opportunities are there for classroom teachers and curriculum developers to link class mathematics teaching and learning with children's informal economic activity?

The project employs a mixed-methods approach and consists of three stages:

1. *Survey.* Questionnaires for the three age groups will be designed to define a contemporary taxonomy of children's economic activities.
2. *Qualitative studies of children's economic practice.* Diary studies will be conducted to make an in-depth exploration of how often children engage in economic activities, and in what particular contexts. Children will be asked to document their activities with mobile technologies such as cameras and mobile phones. Following this, focus groups will be conducted to discuss the economic activities identified both through the diary studies and the survey.
3. *Task based interviews.* These will be conducted to determine the extent to which the knowledge of children's out of school mathematics can be integrated with the formal mathematics curriculum.

Surveying children's economic activity

The survey stage was initiated with the design of different questionnaires for each age group (8-10, 11-13, and 14-16). Some topics inappropriate for younger children (e.g., gambling) will be covered only amongst the older groups. However, the questionnaires for all age groups cover the same three types of economic activities:

1. *Producing.* Any effort to create value, like doing things for pocket money, working, or borrowing money and things (e.g., toys and clothes).
2. *Consuming.* The acquisition of goods and services, mainly through shopping.
3. *Distributing.* Transfers of value in transactions such as swapping, sharing and giving gifts.

150 children in each age group will be surveyed. Here we present initial data from the younger group (8-10). 53 Year 5 children (29 girls) answered the questionnaire. Most (34, 64.2%) were white and the rest represented a range of ethnicities including British black and British Asian. The majority (31, 58.5%) live in families where at least one parent or carer works in a high-level occupation[1]. In spite of its preliminary nature, the data already describes a wide range of economic activities. These results are summarised in three sections: pocket money, economic activities around non-monetary goods, and the mathematics of children's economic activity.

Pocket money. There are both similarities and differences between our survey and previous studies of pocket money. Our participants regularly get pocket money in relatively small amounts and they do not spend it frequently. The minority of our respondents get no pocket money at all (3, 7.9%) or only on special occasions (6, 11.3%). Most children get money regularly, every week (19, 35.8%), every two or three weeks (8, 15.1%) or monthly (17, 32.1%). This is partially consistent with Furnham (2001; 1999) who found that most parents believe children aged 5 or above

[1] According to the National Statistics SEC

should receive pocket money. However, in our survey most of those who receive pocket money weekly get up to £1 (14/19); which is less than the £2 that parents in Furnham's studies reported as appropriate for 10 years olds, and much less than the £4.75 reported as last year's average UK amount of weekly pocket money amongst children 8-11 (Halifax 2010).

Some respondents do not have to do anything to get pocket money (14, 21.4%), whereas about half are asked to do chores (23, 43.3%), which is in line with the 51% of parents who said that pocket money should depend on chores in the study of Furnham (2001).

Our survey also suggests that 10 year olds do not use money frequently. The majority of participants did not remember having spent money during the last seven days (38, 71.7%). In fact, many reported not spending money at all or at least not regularly (22, 41.5%). Only a few spend money every 1 to 3 days (5, 9.4%); and most do it once every 1 or 2 weeks or once a month (26, 49%).

Activities around non-monetary goods. Children's economic activities are not only about money. They might also work around non-monetary goods, such as food (Nukaga 2008), and marbles (Webley 1996). In line with this, our data revealed that non-monetary goods might be as important as money in children's economic activity. In fact, few of our respondents included money amongst their three most valued possessions (6, 11.3%). The objects listed as most valued possession were technologies, including videogame items (26, 49%) and devices such as mobile phones and mp3 players (19, 35.8%). Rather than money, these and other things tend to be the object of economic activities such as borrowing, swapping and collecting.

The majority of children borrow things (40, 75.4%). These children borrow books and comics (21/40), clothes (10/40) and toys and videogames (8/40). They borrow more from siblings (16/40) and friends (12/40) than from their parents (5/40), which seems seems natural: what a child likes is more likely to be owned by a peer than by an adult.

Half of the children swap things with their friends (27, 50.9%). They swap a variety of things including toys or videogames (7/27), comic books and books (5/27), cards (4/27) and clothes (4/27). Similarly, about half of the children collect things (22, 42.15%). They collect things such as toys and videogames (10/22), clothes (2/22), cards (3/22), books or comic books (3/22). Thus, swapping and collecting seem to be fairly common activities amongst children. However, a wide range of things are swapped and collected by small numbers of children, so what is swapped and collected might depend on individual preferences rather than on collective trends.

The mathematics of children's economic activity. Children reported a number of activities that one would expect to require mathematics. Many of these occur at home with the family, such as planning birthday parties (37, 69.8%), shopping for clothes (35, 67.9%), playing board games or card games (64.2%), playing video games (33, 62.3%), buying in the supermarket (33, 62.3%), cooking (31, 58.5%), and planning holidays (26, 49.1%). Some activities might require basic arithmetical operations, for instance shopping for clothes or buying in the supermarket. But other activities might demand more complex operations. For example, children may have to estimate proportions whilst planning the 'goodies' for a birthday party, or calculate probabilities when playing card games. Other sorts of mathematics are likely to be employed in activities that children perform with their peers. For instance, children who collect may have to estimate the value of an object (a card for instance) in relation to the wider 'market' (the cards of others). They will probably have to use this information to bargain during swapping activities (card exchanges for example).

Discussion

The presented preliminary results of the survey show that children as young as 10 years old engage in a range of economic activities where non-monetary goods seem to be equally (or probably more) important than money, and that some of these activities might involve mathematics more complex than basic arithmetic. These findings are promising and we expect to have a wider picture of children economic activity once the survey stage of the project is completed. For example, the data presented reflects the activities of economically advantaged children. Perhaps children in lower socioeconomic strata will engage in other sorts of activities For instance, they are probably more likely to do things such as selling or working informally to get money. Or perhaps they will swap, borrow and collect following different conventions and with other non-monetary goods. As for older children, we expect a wider range of activities. They will have more money and autonomy than 10 year olds and therefore, their economic activities should be more abundant and complex, involving a richer variety of mathematics.

We anticipate that older children will handle more money, and that they will use it more frequently and in a wider range of goods and services than 10 year olds. Moreover, older children should participate more in institutionalized activities such as having a bank account to administrate and save their money, or even using credit. All these aspects might involve complex mathematics, for instance to understand formal economic concepts such as interest rate. Also, the economic activities of older children might involve a wider range of non-monetary goods. Thus, they are expected to report more borrowing, selling, swapping and collecting. These activities might occur over the Internet (e.g., using ebay), especially using their mobiles, something rarely observed in our preliminary data.

When the survey is completed we will be able to see the taxonomy of economic activities. Those activities with the most potential to involve mathematical operations beyond arithmetic will be the subject of in-depth investigation with diary studies and focus groups. This methodology will give us insights about children's economic activities from their own point of view, including aspects such as why they value certain things and not others; their understanding of the rules upon which their economies work (e.g., what gives value to a card or a toy in the economy of their schools or neighbourhoods) and their awareness of the mathematics involved in their economic activity.

To conclude, our preliminary data tell us that children might be learning and using a variety of informal mathematical operations whilst taking part in economic activities. But to link this sort of activity with the formal learning of mathematics in school, we need both an abundant documentation of activities and a deeper understanding of its conventions and the mathematics they involve, especially from children's point of view. This is what the methodology of this ongoing project aims to do.

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