The Use of Convenient Value Strategies among Young Train Vendors in Mumbai, India

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This study analyzes the mathematical understandings young unschooled vendors develop through participation in the culturally based practice of selling small items on the local trains in Mumbai, India. A core assumption of the study is that individuals' goals and the strategies they construct to accomplish those goals take form in relation to social interactions, activity structures, and the understandings people bring to their practices. Analyses of the interviews and observations highlight the role of commonly used values, which I have termed convenient value strategies, in the mathematical understandings as well as in the lived practice of the child sellers. Convenient value strategies provide a link between sellers' mathematical understandings and the practices with which they are engaged.

Anisha, aged 11, sits on the side of the busy Dadar railway platform in Mumbai, India, vending small and large hair bands to passing travelers. Her younger brothers run and play around her, occasionally stopping to assist customers. Every couple of minutes, Anisha calls out to customers "for 10 rupees take 6, for 10 rupees take 6!" [At time of observation, the exchange rate was roughly 40 rupees=US$1] Anisha's mother, who sells the same products on the trains, checks up on her daughter and provides support during transactions when available. Today, Anisha's mother is not selling on the trains and is staying close by her daughter, as the police are actively trying to disperse the sellers and will arrest child sellers who are on the platform without an adult present.

Anisha's story is a common one found on the train system in Mumbai, India. She is a member of a group of train vendors comprised of both children and adults. Anisha lives a life of marginality; her daily earnings are spent on food, with some saved to purchase the items to be sold the next day. Although Anisha and other child vendors like her are largely unschooled, they have developed mathematical understandings linked to commonly occurring values through the practice of vending on the trains. This paper highlights the role of these commonly used values, which I have termed convenient values, in the mathematical understandings as well as in the lived practice of the child sellers. I am defining convenient value strategies as strategies in which numbers take on a role as operators to solve a wide variety of mathematical problems in everyday practices. A convenient value strategy is linked to the cultural practice from which it arises, and thus a value that is convenient in one social context may not be convenient in another. For train vendors, the values of 5, 10, and 20 are what I am terming convenient values. Although these numbers are commonly used in a base 10 system, these values have particular functions in the problem-solving of young sellers.

This paper will examine relationships between the strategies that child vendors use to solve mathematical problems and the practice of vending on the trains. I will report qualitative analysis of observations of children selling on the trains, as well as interviews in which unschooled vendors and same-age schooled children were engaged with solving practice related tasks.

This paper is framed by socio-cultural approaches to analyses of cognitive development in which learning is understood to occur in relation to the emerging goals with which people are engaged in everyday practices (e.g., Saxe, 1991, Vygotsky, 1978). A core assumption in the socio-cultural framework that I use here is that individuals' goals and the strategies they construct to accomplish those goals take form in relation to social interactions, activity structures, and the understandings people bring to their practices. In myriad studies, investigators have shown that the mathematics that people construct in out-of-school practices is interwoven with the conventions used in selling (e.g., price ratios used in selling goods to customers), artifacts (e.g., units of currency), and properties of interactions with others (e.g., customers). Prior findings span child candy sellers in northeastern Brazil (Saxe, 1991), children buying items in liquor stores in the U.S. (Taylor, 2005), farmers selling goods in southern Brazil (Nunes, Schliemann & Carraher, 1993), child sellers in Delhi, India (Khan, 1999), children in two west African societies solving mathematical tasks (Posner, 1982), and straw weavers in Brazil (Saxe & Gearhart, 1990). This study seeks to add to this existing body of work by focusing on the role of convenient value strategies in both the lived practice of the sellers and in their mathematical understandings.

Methods

This study was conducted in Mumbai, India, and consisted of an observational analysis of sellers engaged in vending activities on the trains and railway platforms as well as mathematical interviews of sellers (n=10) between the ages of 8 and 14. A group of schooled non-sellers (n=10) was also interviewed to serve as a contrast to the sellers. The interview study was designed to document the mathematical understandings of child sellers.

Data Source

In the first phase of data collection, sellers were observed on the trains to sketch a portrait of the practice of selling on the trains. Age of child, gender, item being sold, and pricing system used were recorded systematically over the course of 5 days. From this, 10 sellers were invited to participate in the study at the train stations. Children were offered compensation two times the amount they would have earned had they been selling to participate in the study. Child sellers then participated in formal observations, background interviews, and mathematical interviews.

Through the background interview, I gathered information such as age, schooling, parent occupation, and time involved in the practice. The participants were vendors between the ages of 8 and 14. As many children did not know their age, I used a child whose age was confirmed by her parents as a benchmark to estimate the ages of other vendors. 5 vendors were male, and 5 vendors were female. All children were asked if they were selling on the train during local holidays to determine how long they had been involved in the practice. Only vendors that had at least 3 months experience were selected. All vendors had little to no schooling experience (between 1-4 years with irregular attendance). This was difficult to determine as many vendors reported that they were attending school, yet we observed vending on the train everyday during school hours. Almost all sellers were involved in the practice through a family member; frequently, young children accompanied their mothers on the trains while selling, slowly becoming apprenticed into the practice. Figure 1 below shows typical homes of the participants and Figure 2 shows a young vendor engaged in selling on the trains.

I shadowed five of these children for periods of 1-4 hours at a time, and noted transactions with customers. These five children were selected based on availability. I recorded the item being sold, selling price, and interactions with customers.

I recruited non-vendors (n=10) at two local government schools, which vendors would have attended had they been enrolled in school. I then matched the non-vendors with the vendors in terms of age. Non-vendors were currently attending school in grades 4 through 9. None of the non-vendors had selling experience.

In a second phase of data collection, interviews of 20-30 minutes were conducted at or near the train stations with

Fig. 1. Typical homes of the participants

Fig. 2. A young vendor and her mother selling products on the train

sellers and at a school site with non-sellers. The participants were asked to solve 6 tasks (see appendix A). The first three tasks were routine ones based on the mathematics of commonly occurring transactions observed on the trains; the last three tasks were non-routine, involving larger quantities of items to evaluate children's understandings of more general arithmetic principles and strategies. Interviews were video recorded and artifacts were collected.

Results

Sellers' mathematical understandings

Analyses reveal that sellers and non-sellers differ in strategy use when solving practice-related tasks. Sellers were more likely to use convenient value strategies to construct price-ratios and generate solutions, as illustrated in Table 1.

As seen in Table 1, the vendor extends the use of 10 as a value and uses it as an operator, increasing the unit (pencils) systematically by 10 until the goal of 56 pencils is reached. In contrast, the non-seller uses pencil and paper to solve this problem. Sellers were more likely to extend the use of the numbers 5 and 10 as operators to solve the extension problems. Non-sellers were more likely to use either school-based algorithms or utilize pencil and paper. To determine whether non-sellers and sellers differed in their tendency to use convenient values strategies on the mathematical tasks, I used a Kendall's Tau-b test to determine where there was an association between groups on use of convenient value strategies. Statistical analyses show that the difference in the distribution of strategy types (i.e., convenient value strategy use) between sellers and non-sellers was significant at the 1% level for a majority of the 6 mathematical tasks posed to participants.

Convenient value strategies in the practice of sellers

The strategies that sellers used to solve the tasks in the interviews are consistent with observations of the strategies sellers use in their selling practice. Analyses suggest the use of convenient value strategies through the pricing structures that are found on the trains in Mumbai. There were three pricing structures observed: single items at a single price, multiple items at multiple prices, and ratio prices.

Task 2-Non routine: A customer is having a party and wants to give pencils to all the guests. She wants to buy 56. Remember, the pencils cost 5 rupees each. How much will it be? How do you know?

	Strategy	Interpretation
Seller	*Participant #14 says*: If 5 rupees for 1 pencil: then 50 rupees for 10 pencils 100 rupees for 20 pencils 150 rupees for 30 pencils 200 rupees for 40 pencils 250 rupees for 50 pencils then 30 rupees for 6 pencils 250 and 30 is 280 rupees	Child begins by creating ratio of 50 rupees for 10 pencils, then appears to increase the unit (pencils) by 10 until reaching goal of 50 pencils. He then creates ratio of 30 rupees for the 6 pencils needed to get to 56 pencils in all, then adds 250 and 30 to arrive at final answer of 280 rupees.
Non-seller	Participant #17 writes: 56 x 5 = 280	Child used a school-based algorithm to solve problem

Table 1. Exemplars of strategies used

Table 2 summarizes the pricing structures and examples of each one.

Pricing Structure	Example
Single item, single price	Nail polish for 10 rupees
Multiple item, multiple prices	Hair clips for 5 rupees, earrings for 10 rupees
Ratio prices	Hair bands-7 for 10 rupees

Table 2. Typical pricing structures

Although there was a large variety of items being sold on the trains, everything observed was sold at either 5, 10, or 20 rupees; there were no items priced for 3 or 7 rupees. Thus sellers' everyday exposure to and reliance on these pricing schemes provided these children opportunities to construct their mathematical understandings. As sellers engaged with problems in the selling practice, the values 5, 10, and 20 took on a function beyond an amount of currency; they became operators with which children solved price-ratio problems. Working on the trains every day, young vendors became familiar with these values by conducting numerous transactions in which they had to sum the total cost of the items as well as calculate the change.

Observation No. 2: 11 year old seller. Meena is selling combs and hair clips for 5 rupees each. A customer chooses 7 hair clips from a box and asks for the total price. Meena responds **35 rupees**. The customer gives her a 50 rupees note. Meena takes out a 10 rupee note and asks the customer to buy one more hair clip to make the total cost 40 rupees, as she does not have change. The customer agrees, selects one more hair clip, and takes the 10 rupee note.

The above transaction demonstrates that sellers were able to engage in these transactions quickly and efficiently. The trains were also very crowded and speed coupled with accuracy was essential. The knowledge they constructed was robust and generalizable; when sellers solved non-routine problems with unfamiliar large values, they successfully extended their use of convenient value strategies to solve these tasks. See appendix A for more examples of sellers' convenient value strategy use.

Discussion

The findings from this study add to the body of knowledge about the ways that mathematical cognition can arise in situations other than formal schooling, and place value on the knowledge that unschooled children develop. My work with young train vendors in Mumbai adds to this work by showing that particular patterns of selling become used in children's efforts to solve familiar and unfamiliar tasks, that those solutions have clear links to their practices through the use of convenient values of currency, and that unschooled sellers' approaches are distinct from those schooled children who do not participate in the selling practice.

There are practical implications for mathematics teachers and curriculum developers. Many efforts are being made to document the ways children approach and engage with mathematical problems in a formal school setting; this research focuses on ways that children construct mathematics in out of school settings, and the findings can help educators devise practices that bridge the gap between formal schooling and informal learning.

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Appendix A: Sellers' Convenient Value Strategy Use

	Routine	Non-routine
Single Price	*1.* Let's say you are selling pencils for 5 rupees each. A customer wants to buy 4. How much will it be? How do you know?	*2.* Now, a customer is having a party and wants to give pencils to all the guests. She wants to buy 56. Remember, the pencils cost 5 rupees each. How much will it be? How do you know?
	Examples: *Participant #12, 11 year-old seller:* *She said:* 5 rupees for 1 pencil, 10 rupees for 2 pencils, 15 rupees for 3, and 20 rupees for 4 pencils. *Participant # 6: 10 year old seller:* *She said:* 5 rupees for 1, and 5 rupees for 1 is 10 rupees. 10 rupees for 2 and 10 rupees for 2 is 20 rupees for 4.	*Example:* *Participant # 11, 14 year-old seller:* *He said:* 40 pencils for 200 rupees, so there are 16 pencils left, and 10 pencils are 50 rupees, for 6 pencils are 30 rupees. So 280 rupees.
Multiple Prices	*3.* Let's say that you are selling pencils for 5 rupees each and pens for 10 rupees each. A customer wants 4 pencils and 3 pens. How much will it be? How do you know?	*4.* Now, a customer comes up to you and says that she needs lots of new pencils and pens for her school. She wants 34 pencils and 40 pens. How much will it be? How do you know?
	Example: *Participant # 13, 10 year-old seller:* *She said:* 5 rupees for 1 pencil, so 10 rupees for 2, and 20 rupees for 4 pencils. Then 30 rupees for 3 pens. So 50 rupees.	*Example:* *Participant # 10, 10 year-old seller* *He said:* 600-30 rupees. The interviewer asked him how he knew. 400 rupees for 40 pens. It's 30 plus 4 pencils, so 30 pencils for 150 rupees, and 4 pencils for 40 rupees, 170 for the pencils. So it's 170 plus 400 rupees.
Ratio Prices	*5.* Now let's say that you want to sell these yellow pencils. You sell them for 5 rupees. for 2. A customer wants to buy 6. How much will it be? How do you know?	*6.* Remember, you are selling 2 yellow pencils for 5 rupees. A customer again wants to buy many for her school. This time she wants 43. How much will it be? How do you know?
	Example: *Participant #12, 11 year-old seller:* *She said:* 2 pencils for 5 rupees, 4 pencils for 10 rupees (counting each group of 2 on her fingers) and 6 pencils for 15 rupees. *Participant # 4,10 year-old seller:* *She said:* 5 rupees for 2 pencils. She then repeated this ratio two more times and then said So 15 rupees for 6 pencils.	*Example:* *Participant # 5, 8 year-old seller:* *She said:* 5 rupees for 2, so 10 rupees for 4, then 20 rupees for 8, then 40 rupees for…. She stopped, lost track of the number of pencils, and began again. She did this again, then stopped and said she didn't know the answer.