# DOES PARTICIPATION IN HOUSEHOLD BASED WORK CREATE OPPORTUNITIES FOR LEARNING MATHEMATICS?

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The National Curriculum Framework for school education in India (NCF, 2005) states as one of its fundamental principles, the building of connections between the school curriculum and the child's life outside school (NCERT, 2006). It recommends that the knowledge gained from outside the school be seen as a resource for learning in the classroom. This is an acknowledgement of research findings in India (Khan, 2004) and elsewhere that children from economically disadvantaged backgrounds acquire significant knowledge outside the school. In India, as in other developing regions in the world, many children participate in the income earning activities of the household, which may enable them to possess impressive levels of knowledge and awareness. Educators have seen in this a potential to not only offset the educational disadvantage stemming from low socio-economic background, but also a possible way of countering the culture of rote learning that is pervasive in Indian education.

Optimism about knowledge acquired by children outside school, especially mathematical knowledge, being a potential springboard for learning school mathematics is evident even in the early writings on 'out-of-school' mathematical knowledge (Nunes, Carraher & Schliemann, 1985). However, despite many studies exploring the contours of such knowledge and its settings, its integration with the school mathematics curriculum remains limited.

Our research has involved a study of 12-13 year olds from low income urban households studying in government schools, who participate in or are exposed to income earning household based work[1]. The objective of the study is to explore the mathematical knowledge that students can access in relation to such contexts, and its potential in learning core areas in the middle school mathematics curriculum such as proportionality, measurement and algebra. The issues surrounding the relation of school learning to knowledge accessed outside the school setting are complex, and several perspectives and approaches have been taken by researchers (Nasir, Hand & Taylor, 2008). Our approach has been to probe the diversity of settings that children within a single classroom have access to, and to situate these in a larger dynamic that shapes both mathematics education and the work settings. The ethnographic study is followed up with instructional sessions with the students aimed at exploring possible connections between the school curriculum and knowledge gained outside school. In the sections below, I'll briefly present a historical background, a theoretical perspective and attempt to situate our study within this context.

[1]This research is done in collaboration with my colleague, Arindam Bose. I thank him for permission to use data collected from interviews of students.

## A HISTORICAL PERSPECTIVE

A look at the elementary school mathematics textbooks from Western India from the late 19th and early 20th Century reveal that the bulk of the curriculum consisted of topics related to everyday commerce (Gokhale, 1921; Potdar, 1922). The several chapters on the four arithmetic operations are separated into two sections dealing respectively with simple and compound operations. Compound operations involve computation with quantities expressed in multiple sub-units. For example, the sub-units for weight had the relation 1 *ser* = 24 *tola* = 24 × 12 *maasa* = 24 × 12 × 8 *gunja*. A weight measure notated as "2 14 5 0" would mean 2 sers, 14 tolas and 5 maasas. Compound operations involved computation with such mixed or "compound" numbers.

A complex and extensive system of measures expressed in the form of conversion tables was an important part of the elementary mathematics textbooks. Conversions between British, Indian and local units were presented in detail. Students were presumably expected to be familiar with these units, and to be able to carry out computation with them. The textbooks also contain an extensive chapter on computing with fractions. Somewhat unexpectedly, the fractions dealt with are base four fractions expressed using an alternating vertical-horizontal "rod" notation. This may have been because the sub-units of money (and some other measures) were based on division by four. The textbooks also contain chapters with problems on simple and multiple proportion and interest calculation.

The extensive treatment of arithmetic and the detailed exercises with a variety of units suggest that such skills were needed and valued in the everyday world of commerce around the time when the textbooks were written. In the "new arithmetic" textbooks from the 1930s, compound operations and base four fractions are completely omitted and the curriculum begins to take a recognizably modern shape (Deshmukh, 1935). In the light of the recommendation of NCF 2005, it is striking that textbooks from a hundred years ago show a strong connection with life outside school, while educators worry about the lack of such connections in modern textbooks.

## MATHEMATIZATION AND DEMATHEMATIZATION

Several researchers have identified demathematization as a pervasive trend in the circulation of mathematical knowledge in the culture. "[Demathematization] also refers to the trivialisation and devaluation which accompany the development of materialized mathematics; mathematical skills and knowledge acquired in schools and which in former time served as a prerequisite of vocation and daily life lose their importance." (Keitel, Kotzmann & Skovsmose, 1993, quoted in Jablonka & Gellert, 2007, p. 8) Demathematization with respect to explicit knowledge and skill accompanies the process of the mathematization of society, i.e. the incorporation of implicit mathematical knowledge in artifacts, instruments and practices. "The greatest achievement of mathematics... can paradoxically be seen in the never-ending, two-fold process of (explicit) *demathematizing* of social *practices* and (implicit) *mathematizing* of socially produced objects and techniques." (Chevellard, 2007, p. 60, emphasis original)

The arithmetic of the compound operations in the older Indian textbooks was needed because decimal numbers were used to compute with systems of units that were not decimal. The skills of computing with a variety of compound units and with base four fractions became redundant upon the adoption of a standardization system of units and measures at the national and the international level. Standardization is one of the means by which demathematization takes place. Other ways are the incorporation of arithmetic in artefacts and devices: calculators make paper-pencil calculation redundant; comparative EMI tables make it unnecessary to calculate interests. Demathematization is also devaluation and hence impacts learning opportunities which are framed by what the culture values and perceives as useful.

## MATHEMATICAL KNOWLEDGE IN THE HOUSE-HOLD ECONOMY

An explicit objective of out study is to explore connections between such learning and (a possibly redesigned) school mathematics curriculum. The location of the study is a large urban low income locality which had a vibrant house-hold based economy. Roughly one third of the students chosen randomly from a whole class studying in the Urdu medium and a whole class studying in the English medium formed the sample. Extensive interviews of these students have led to a profile of the kinds of income generating work that they participate in or are exposed to, and their basic arithmetic abilities and skills. More detailed ethnographic data is being obtained through interviews done with a selected sub-sample of the students.

Some houses in the locality have small workshops or factory units adjoining or in them, while in many houses activities are done within the house, which include embroidery, *zari* (stitching sequins onto cloth), stitching, garment-making, making plastic bags, leather goods (bags, wallets, purses, shoes) and decorative items, repairing, catering, vending, etc. A large number of children in our study participated in one or more of such kinds of work, often inside the house, and in some cases in a shop or workshop. In some houses, children were discouraged from participation in work and were encouraged to focus on studies. But even children from such households develop a fair knowledge and reality perspective about the activities around them. Nearly all children regularly buy groceries or provisions for daily house-hold needs from neighbourhood shops.

Students in the study generally showed flexible competence in arithmetic in contexts dealing with money (Bose & Subramaniam, 2011). Many could compute mentally and arrive at quick decisions when the situation required addition or subtraction, or multiplication and division by small numbers. Some students struggled with reading and writing numbers larger than 3 digits, although they could deal with such numbers as amounts of money. Detailed interviews with students revealed more about the nature and diversity of work that students participated in. The perspective framed by accounts of mathematization/demathematization helps illuminate many aspects of the settings in which work is carried out. However, the interviews also reveal a situation that is fluid and dynamic in many respects.

The general trend of a shift from craft based industry to large scale factory based manufacture is resisted by small-scale house-hold based industry, which is an outcome of the initiative and enterprise of economically disadvantaged people struggling to make a living. This represents a counter-trend against deskilling and the depletion of craft-based knowledge, as existing knowledge is adapted, modified or new kinds of skills and knowledge arise. Such resistance to deskilling can be read as a counter trend to demathematization, since the need for mathematical skills arises in the course of the bargaining, negotiation and decision making concerning wages, costs, commissions, interest, in dealing with a variety of goods and quantities measured in diverse units. It is emblematic of this counter-trend that old British units such as inch and foot, or even Indian units such as the *gaj* (equivalent of “yard””), that were sought to be exiled through standardization continue to be used in such occupations. A variety of formal and informal units are used to indicate the quantity of raw materials in different sectors of small-scale manufacturing such as tailoring, sequin-stitching, leather work, catering, etc. While formal units belong to a system of units (international or indigenous), informal units are units of convenience, may not be defined precisely quantitatively, and may be partly embodied. An example of an informal unit is a '*mutthi*' or 'fistful' of raw materials, used in *zari* (sequin) work (Subramaniam & Bose, 2012).

The extent of knowledge of measurement among students varies. One student could draw a line one inch long with accuracy, while another student participating in tailoring work confused inches and centimeters (both marked on the tape he was familiar with). Students encounter numbers and measures of different kinds, but the mode of quantification remains obscure. Shirt sizes, for example, were seen as mere numbers bereft of units and without an idea of how the numbers were obtained.

Knowledge related to measurement among the students has aspects of familiarity through participation in work, but is also partial and fragmented. This is reflected in the division of labour and compartmentalization of groups involved in making small articles. Repetitive processes with a stress on the quantity of production characterise not only factory based production but also house-hold based industry. Goods are often delivered as nearly finished goods, with only a small part of the manufacture to be completed in the house-hold. For example, some house-holds are involved for a few months in a year in making '*rakhis*', decorative strips of cloth and thread tied around the wrist for the Hindu festival of '*Rakhsa bandhan*'. Colourful flowers already cut into shape from plastic or paper and decorative threads are collected by a family member from a middleman, and the work to finish the *rakhi* involves only glueing or threading. In a tailoring shop, pieces of cloth that make up a shirt already cut into shape are delivered and the work that remains is only of stitching the pieces together and sewing buttons. A former master tailor who runs the shop now only needs to attend to managing the production of shirts in large numbers.

## CONCLUDING REMARKS

An exploration of the mathematical knowledge gained by students through participation in work reveals familiarity with “materialized” mathematics embedded in the culture. Knowledge of mathematics in such contexts may show flexibile competence in some domains such as arithmetic computation, but may be partial and fragmented in domains such as measurement. The settings in which such knowledge is acquired do not foster the gaining of “mastery knowledge”, nor is such knowledge readily available in the environment in which work is done. Further, the frequently compartmentalized nature of work, its routinization and repetitive nature are consistent with the limited and fragmentary knowledge gained through them. It is possible that compartmentalization and simplification are the very factors that allow children to participate in the work, but this also means that they and the house-holds have little control, negotiate fluid identities and experience a variety of injustices in the course of such work. School education, perceived as a means to a better future, is seen as distinct from this mileu, and efforts to build bridges between the culture and school education need to take cognizance of these aspects.

The goal of a mathematics curriculum sensitive to the interaction of mathematics in the domains of work and play, must take account of the distinction between mathematics *in* work related activity and mathematics *as* activity, between mathematics *in* the culture and mathematics *as* culture. Connecting the learning of mathematics in school with culture can take the form not only of guided re-invention as in the Realistic Mathematics Education approach (Treffers, 1993), but also of a history or archeology of “materialized” mathematics embedded in the artifacts or practices of a culture. The context of measurement is an instance of such possibilities that need exploration. In instructional sessions with students in the study, the familiar “inch-tape” was a central artefact around which, exploration of the following concepts of measurement was structured: the concept of a unit length, the sub-division of a unit, use of fractional and decimal notation, and the activity of measurement. At the end of two weeks of instruction, in their responses during focus group discussions, students appreciated the fact that they had gained a deeper understanding of something as familiar as an inch-tape. We believe that such "archeology” may have an important place in providing opportunities to learn mathematics to students who obtain a fragmented and partially obscured form of mathematical knowledge from informal work environments.

### References

Bose, A. & Subramaniam, K. (2011). Exploring school children's out of school mathematics. In Ubuz, B. (Ed.). *Proceedings of the 35th Conference of the International Group for the Psychology of Mathematics Education*, Vol. 2, pp. 177-184, Ankara, Turkey: PME.

Chevellard, Y. (2007). Implicit Mathematics. In U. Gellert & E. Jablonka (Eds.), *Mathematization and de-mathematization: Social, philosophical and educational ramifications* (pp. 57–66). Rotterdam: Sense.

Deshmukh, G.M. (1936). *New Arithmetic for Class 4.* (In Marathi language).

Gokhale, G.K. (1921). *Arithmetic: Part 1* (14th Edition). (In Marathi language. Original edition from the 1890s).

Jablonka. E. & Gellert, U. (2007) Mathematisation—demathematisation. In U. Gellert & E. Jablonka (Eds.), *Mathematization and de-mathematization: Social, philosophical and educational ramifications* (pp. 1–18). Rotterdam: Sense.

Khan, F. A. (2004). Living, Learning and Doing Mathematics: A Study of Working Class Children in Delhi. *Contemporary Education Dialogue*, 2, 199-227.

Nasir, N. S., Hand, V. & Taylor, E. (2008) Culture and Mathematics in School: Boundaries between "Cultural" and "Domain" Knowledge in the Mathematics Classroom and Beyond. *Review of Research in Education*, 32 (187-240).

Nunes, T. C., Carraher, D.W., & Schliemann, A. D. (1985). Mathematics in the Streets and in Schools. *British Journal of Developmental Psychology*, 3, 21-29.

Potdar, G.V. (1915) *Arithmetic, Books 1 to 4.* 28th Edition. (In Marathi language).

Subramaniam, K. & Bose, A. (Forthcoming). Measurement units and instruments – the Indian context. Paper to be presented to the Topic Study Group on Measurement (TSG 8), *The 12th International Congress on Mathematical Education*, Seoul, South Korea.

Subramaniam, K. & Banerjee, R. (2011). The arithmetic-algebra connection: A historical-pedagogical perspective. In Cai, J. & Knuth, E. (Eds). *Early Algebraization: A Global Dialogue from Multiple Perspectives*. Springer, 87-107.

Treffers, A. (1993) Wiskobas and Freudenthal: Realistic Mathematics Education. *Educational Studies in Mathematics*, 25: 89-108.