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**FROM SCHOOL TO WORK:
A SOCIAL AND PSYCHOLOGICAL HISTORY OF MATH IN A NEPALI VILLAGE¹**

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Public schooling in Nepal has been a principle component of social change in Nepal since late in the Rana oligarchy (Sharma, 1990). Changes in mathematics both mark and are part of a broader set of social transformations many Nepalese villages have undergone since the fall of the Rana oligarchy.

At first glance, mathematics may seem an incongruous candidate for examining social change in Nepal. We tend to regard mathematics as the most abstract, logical, and acontextual of our knowledge domains. This does not reflect our actual use of math so much as our mathematical training in school, whatever part of the world we are from. Having thusfar avoided the "homogenized" state of mathematics in the U.S. and Europe, Nepalese society continues to manifest its extensive history of math originating from various work and religious practices and only a recent, albeit intensive, exposure to math through schooling. The recent advent of schooling, in conjunction with changing work practices, has promoted differences between coexisting generations of villagers in how they acquire math, how they use it and how they may gain selective access to the math of the other generation. During this same period mathematics has acquired increased importance for the general rural populace; both as a marker of academic success and as a work skill.

Differences between the mathematics of coexisting generations of Nepalese villagers do not grow out of their individual psychological histories nor do they spring directly from societal shifts in mathematical systems. Rather, the generations represent momentary points in an ongoing dialectic between what societal transformations afford a person's development and what people afford societal development.

The event that follows illustrates not only typical discourse between a student cum shop apprentice and a village shopkeeper, but also the conflict between personal and societal transformations in mathematics across the two generations.

Raja is an 18 year old student attending the local high school. He is working as an apprentice to a shopkeeper of his grandfather's generation. Public schools did not exist in the village during the shopkeeper's youth. Raja plans to open a shop of his own in a neighboring village after he finishes 10th class next year. The shop is busy when a farmer comes in and asks for *aadha bisauli* (half a *bisauli* weight measure) of nails. Raja hesitates, even though he knows that a *bisauli* of meat weighs a bit over a kilo. The shopkeeper tells him it's about 625 grams, weighs out the nails, says a kilo costs 25 rupees, and tells Raja to finish the transaction. Raja

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takes several minutes to write out the equation "1000 over 25 is 625 over what?" He then divides 25 into 1000 on paper to get 40 and 625 by 40 to get 15.625. Looking puzzled, he asks the shopkeeper how much 15 point 625 grams of the nails costs. The shopkeeper turns from a customer and tells Raja that using pencil and paper for such simple things is going to create problems and take too much time. "Listen..." the shopkeeper tells Raja, "half of 1000 is 500, so half of 25 is 13 rupees. Half of 500 is 250 and half of 13 is 6 rupees and 50 paisa, and half of 250 is 125 so that's 3 rupees and one *sukha* (25 paisa) for the leftover 125 grams. So 13 rupees and 3/25 is 16/25, so take 16 rupees from him." Throughout this rapid recitation Raja has attempted to write the shopkeeper's math on paper for future reference.

The remainder of this article sketches several histories of education and work in Nepal. Within this, they focus on patterns of math use between members of two generations of villagers: students who are becoming shopkeepers and shopkeepers who have not attended school. Together these histories explicate the meaning of interchanges like Raja's and the shopkeeper's by taking present-day interchanges to be part of a broader dialectic between societal and personal change that continues to unfold in rural Nepal.

The historical sketches are three in number: education and work in Nepal, school and work activities in a village and persons moving between school and work activities in that village. These histories grow out of a larger research effort concerned with levels of change between school and work mathematics in Nepal. The three histories are not reducible to each other, do not recapitulate each other, and can not be explained using a single principal. At the same time, each history does not exist independent of the others and affords the other certain transformations. (See Vygotsky, 1962; Scribner, 1985; Seddon, Blaikie, & Cameron, 1981 for more elaborated discussions of historical levels and change)

Education and Work in Nepal

Learning marked as schooling in the European vein occurred in a wide variety of restricted forms during the Rana period in Nepal from the mid-1800's to the mid-1900's. A tradition of Vedic and Buddhist education existed at least as far back as the first or second century A.D. during the Licchavi period. All of these, however, were "pedagogy for the select" of one form or another and did not take on the character of an education movement within Nepalese society as a whole. Despite this, the Ranas experienced difficulties in their attempts to limit public access to education as Sharma (this issue) has discussed. This was due in part to outside pressure from India and Great Britain and the perceived internal alignment of public education with opposition to the Rana oligarchy. With the Ranas overthrow in the early 1950's by the Shahs, the current ruling family, the development and institutionalization of national public education rapidly took place.

Until the 1950's schooling's prime function had been seen as elevating its students in social or religious status--not necessarily preparing them for work. With the institutionalization of public education came official goals of public education. The goals were directed toward preparing citizens to meet national needs for improved agriculture and technical skills, among others (Aryal, 1970). There has been some degree of meshing between educational background and work in the urban sections of the Kingdom. This is due in large part to a significant percentage of urban students continuing on to higher education and the availability of urban clerical and technical jobs (Manandhar, 1987).

This has not been the case for the majority of Nepal's populace which is rural. Most rural students do not pass their school leaving exams at the end of high school. Of those who studied beyond the primary level in 1970, an estimate from government figures (MOEC, 1984) suggests that only 5 to 6 percent successfully completed 10th class and their school leaving examinations. Without a School Leaving Certificate, education does not generally increase rural students access to non-agricultural jobs. Therefore the prime livelihood for most of these former students remains agriculture--producing largely for their own consumption.

Simultaneous with the expansion of public education and a decline in indigenous manufacturing, there has been an expansion of small business enterprises in the villages, particularly repair facilities for imported goods, and retail shops (Blaikie, Cameron, & Seddon, 1978). These enterprises, initially entered into by villagers with little or no formal education, are now being entered with increasing frequency by former students. Most of this 'informal sector' remains at the marginal or subsistence level and serves

as a supplement to agricultural work rather than generating major capital accumulation. However, a survey we carried out in one district indicated that among those small business enterprises that operated beyond the subsistence level, a large majority were run by villagers with some degree of formal education. The reverse was true among those small business enterprises that operated at the subsistence level.

These developments in education and work at the national level are not a summation or an average of the changes that were occurring within Nepal's villages. Rather, they are directly intertwined with economic and political changes that occurred within Kathmandu Valley and beyond Nepal's borders, as well as changes in the rural areas. Villages underwent their own more local changes in education and work, through they were shaped by the institution of public schooling and informal sector enterprises.

School and Work Activities in the Village

Bhimghat is currently located in a middle hills valley in Western Nepal. It was located high on a hillside facing the valley until the eradication of malaria in the late 1950's. In 1948 Mohan Shamsher, a Rana Prime Minister, granted Bhimghat a charter to open a school and provided 500 rupees annually for the salary of a teacher hired from India. The school was held in a villager's house with 10 to 15 students attending at any given time. The teacher taught math using a combination of Sanskrit and "English" systems. English was requested by several villagers who had served in the British Gurkha regiments.

Tulo Barna Malla math was derived from Sanskrit instruction and involved a mixture of *devnagri* numerals and tallys. It was ideally adapted for shopkeeping because the tallys referred directly to *anna* (using the 16 *anna* equals 1 rupee system in force at the time) and *paisa*. Unfortunately, there were no shops in the hillside village. Rather, each family made an annual trading trip to India for supplies. This form of math remained confined to the classroom as a result. The second system of math taught in the class involved the use of Hindu-Arabic numerals and the basic math algorithms for the four operations familiar to all of us. This form of math did not lend itself to a particular function or set of units, unlike *Tulo Barna Malla* math. However, its social status in Bhimghat was above that of the Sanskrit-derived numeracy because of its association with the British. Like math from the *Tulo Barna Malla*, however, its use remained largely confined to the classroom.

During this time the general populace of Bhimghat had few encounters with the math taught in these classes. Math outside of the classroom involved the use of three different sets of devices, each with its own procedures. Seeds and stones carried in a pouch were used to establish one-to-one correspondences with livestock. This functioned as a means of detecting missing livestock without requiring full knowledge of numerical values. Some villagers used stones independent of livestock to quantify increasing amounts and decreasing amounts using different forms of counting. Finger counting was used across a wide variety of situations to quantify increasing and decreasing amounts as long as the amounts did not have to be grouped or regrouped into subquantities (as in multiplication and division). Finger counting was not useful for dealing with the larger quantities, though it was not limited to a quantity of 10 as the joints and tips of the fingers were usually counted rather than the fingers themselves. A tally system was used exclusively for monetary transactions and was based on various subdivisions of the 20 rupee currency note, the largest available at that time. For record purposes, one *bisa* (*bis* meaning twenty) received the longest tally, a half *bisa* tally (10 rupees) was half the length of the *bisa* tally, etc. down to a one rupee tally. Unlike stones and fingers, the written tallies provided a relatively durable record of quantity. Interviews with elders in Bhimghat today suggest that many of the math calculations performed without the aid of these devices during the 1950's followed mental procedures similar to the procedures used with the devices. It is not known whether other procedures unique to mental calculation were used.

With the eradication of malaria, villagers gradually shifted from the hillside to the valley, a location they had previously only visited during the day for farming. In 1960 the first primary school was established in the valley as part of the national system of education. This was followed by a lower secondary school in 1969 and an upper secondary school in 1974. Three additional primary schools were functioning in Bhimghat by 1988.

Increasing percentages of village children attended primary school where arithmetic was taught using *devnagri* numerals and column algorithms for the four basic operations. By 1988 over 900 students were enrolled in the Bhimghat schools. Math facts were learned by the collective chanting of math problems

and answers from textbook tables. Finger counting was discouraged while teacher-student discourse on math followed the pattern of teacher asking question, student(s) answering question, and teacher evaluating answer: a pattern of classroom discourse common to most subjects.. Algebra and geometry were introduced at the secondary level in addition to arithmetic. Beginning at this level all math was carried out using Hindu-Arabic rather than *Devnagri* numerals. One or two chapters in each class's arithmetic textbook were devoted to learning metric measures. Only the earliest math textbooks made reference to the non-metric measures such as *maana* and *dharni* more commonly used in Bhimghat. Next to English, mathematics was considered to be the most difficult subject by a majority of the secondary school students. Their test results bore this out as 65 percent did not pass math. In 1987 roughly 40 percent of the village's 5th grade primary students did not continue their schooling. Of those who did not continue their schooling, 80 percent had failed or were failing mathematics. In the same year only 20 percent of the 10th grade students passed their school leaving exams. Most who did not pass were in the village workforce in 1988.

Shopkeeping followed the expansion of public education in Bhimghat. This was not a coincidence. Paying children's school tuition, purchasing textbooks at the upper grades, purchasing school supplies and the removal of their children from the home workforce were often cited by farmers as creating an increased need for cash income. Agriculture held little cash-generating potential for most of the farmers whereas shopkeeping directly generated a cash income. A number of students from neighboring villages boarded in Bhimghat while attending its schools. Also, students created an expanded market for many items not readily available from the villagers' homes such as soap, cigarettes, and biscuits. Given such ties with schooling, it is not surprising that the first two shops in Bhimghat opened on the perimeter of the primary school compound in 1969, selling tea, sweets, notebooks, and pencils to the students. Since that time the number of general retail shops, tea shops, medical halls, and repair services in Bhimghat has increased to over 40.

Shopkeepers' sons and brothers and occasionally their wives initially assisted in running the shops. These same relatives opened most of the new village shops during the 1970's. Most shopkeepers during this time had little or no formal schooling. Relying on tallies, fingers, and elaborate but rapid mental calculations they marked up prices, totaled items, calculated change, and made conversions between units of measure and price. Some of their math procedures were expansions of those they used in farming. Others were specific to shopkeeping. The size of most of these shops and the diversity of their stock was limited, however.

During the last decade a series of broader changes afforded the incorporation of written notation and column algorithms into the already extensive repertoire of math procedures used by those who began shopkeeping in the previous two decades. The first change involved the 100 rupee note becoming the common high value note in Bhimghat, replacing the 20. This rendered the *bisa* system of quantifying price less wieldily than a 100 rupee-based system that was directly translatable into column values. A second was the opening of a roadhead to the Terai and India within walking distance of Bhimghat. This allowed a more diverse range of goods to be stocked by the shops. Some of these items, such as cloth, required new forms of calculation that lent themselves to column algorithms. Third, prices increased as did the size of the purchases made by villagers. The resulting general increase in the size and quantity of numbers used in calculations strained some shopkeepers' existing calculation techniques. Column algorithms, however, could be applied to any size and quantity of numbers. The final change consisted of His Majesty's Government ordering that all applicable shop items be priced in metric units. The metric system takes full advantage of the base 10 system with respect to defining its units. Therefore column algorithms are easily applied to calculations involving translations of metric quantities into price. The same is not true for many of the non-metric systems. For example *gaj*, a measure of length, is divided into 9 equal segments.

The recent changes in shopkeeping and the village economy as well as the increased accessibility of schooling have created many new ties between schooling and shopkeeping in Bhimghat. At the same time the relative stability of farming practices in the village has resulted in few new relations being forged between farming and schooling, though nearly all the teachers and students participate in some form of farming activity. Shopkeeping, however, has evolving ties to both farming and schooling. This is reflected in the broad repertoire of math procedures used in most of the shops today. Conversions between non-metric measures used in farming and metric measures taught in school are common. Calculations often

combine finger counting, written notation using column algorithms and mental strategies which reflect both counting and column strategies. A number of new mental strategies specific to shopkeeping have been developed as well.

Most Bhimghat shops opened during the latter half of the 1980's were opened by former students who had not passed their school leaving exams or had never attempted them. Unlike new shopkeepers in previous decades, former students were usually the first member of their families to attempt shopkeeping. They initially approached math in the shops using column algorithms and written notation and only gradually acquired a wider repertoire of mental calculation strategies; some specific to shopkeeping. This is approximate reversal of the path followed by the previous two decades of Bhimghat shopkeepers who have only recently acquired written notation and column algorithm procedures.

Students and Shopkeepers Moving Between School and Work in the Village

As of 1988, none of the Bhimghat shopkeepers over 45 years of age had direct contact with public schooling, though two had attended private classes during the 1950's. Of those with no school experience of any kind, over 80 percent are now able to read and write three-place numerals. Sixty percent are able to perform four and five place addition and subtraction calculations using column algorithms. These shopkeepers found it useful to learn numerals and portions of the calculation techniques taught in school. Most of these shopkeepers learned this math from their children and younger siblings who attend school.

This is not to say that what they learned was "school math." In many cases the shopkeepers of this generation use written numerals as mnemonic devices rather than for calculation. Calculations are then carried out using mental strategies specific to shopkeeping such as the one the shopkeeper recited to Raja. In other cases column algorithms are used, though in a manner different than taught in school. Most of this generation of shopkeepers have not learned the addition, subtraction, multiplication, and division signs that are so common to and necessary for school math problems. A customer's purchase determines the operations rather than the math itself. Signifying math operations is therefore superfluous. This generation of shopkeepers has generally learned only those portions of school math that are seen as useful to them; incorporating them into their wider repertoire of math techniques. They are then able to choose from their math repertoire based on the nature of a particular purchase by a particular customer.

Unlike the shopkeepers who learn only those aspects of math taught in the schools relevant to shopkeeping, former Bhimghat students initially approach shopkeeping with a view that customer purchases are essentially math problems and therefore must be solved on paper. They need to work through a number of difficulties in the process of broadening their repertoire of math techniques as shopkeepers.

The students must first overcome the differences in status that exist between the various math techniques. Written numerals and calculations have higher social status in Bhimghat than mental math or devices such as fingers and stones. Many of the students refer to these techniques not as *hisaab* (math), but as *andaaji* (guesstimate) or *laato hisaab* (dumb math). The strength of this status difference is voiced by a number of Bhimghat elders who recall when their math was *the* math, though they themselves now refer to it as *andaaji* in the face of "true math like students learn in school."

A second hurdle for the students involves using different systems of measurement. Many shop customers are farmers who are only marginally familiar with metric measures. This often requires that their requests, made in non-metric units such as *haat* (length from elbow to tip of index finger) and *muthi* (handfull) be translated into metric units so that they can be priced. Though many of the students are familiar with non-metric farming measures as well as metric measures, they have no experience in converting from one system to another. Their initial attempts at conversion are complicated by the lack of non-decimal multiples between the two systems of measurement. This often results in solutions being uselessly carried out to a large number of decimal places as well as a large number of errors.

A further challenge to doing math in the shop comes out of the actual structure of math problems taught in the classroom. Students are usually taught to approach math problems with multiple operations in the following manner, using an illustration from a 8th class teacher, "First you divide the larger into the smaller number to get the percentage, then you multiply the percentage and the price, and then add the

two prices together to get the answer." The goal is to get the correct answer using the procedure. The goal does not contain any information relevant to organizing the sequence of operations; that is fixed through the memorization of a procedure. Calculating customer purchases in the shop often calls for various combinations of math operations. Though the goals and structure of most customer purchases provide useful information for constructing an appropriate sequence of operations, students are initially unable to make use this information. This situation is often further complicated by experienced shopkeepers using strategies that do not lend themselves to categorization by mathematical operation.

The personal paths that lead toward the development of a broad repertoire of math procedures are clearly different for these two generations of Bhimghat shopkeepers. One generation of has come out of farming with only indirect access to schooling. The other is coming directly out of school. The two paths have different consequences for the two generations; both in terms of their math skills and in terms of the type of shop they can maintain. The existences of these two paths are tied to evolving relations between school and shop practices in Bhimghat and, through this, changing socio-economic relations between education and work in Nepal. Projecting into the future, the path taken by the older generation of village shopkeepers will not be afforded for the upcoming generations of shopkeepers. This may seriously alter the economic function of rural shopkeeping for individuals. Further hypothesizing suggests that the resulting unavailability of the elder generation of shopkeepers' math repertoire will limit math skills available to future generations; perhaps finally resulting in the homogenization of mathematics that Nepalese society has thusfar avoided.

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