3. Indigenous traditions and the colonial encounter: A historical perspective on mathematics education in India

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Introduction

In this article, we try to provide a broad overview of the historical processes associated with the evolution of modern mathematics education in India, with a focus on elementary mathematics education. We try to organize this narrative around two issues that are of contemporary relevance. One, contending ideals about objectives of mathematics education in relation to functionality as a desired goal (or otherwise) in school mathematics. Second, the disconnect between the learning processes in school and those outside of it. This does not amount to projecting present concerns on to the past. Attempts to reconstruct a history of mathematics education in India during the eighteenth and the nineteenth centuries tend to reveal the above two aspects as central strands to what is otherwise a complex story. The sources for this complexity, it should be mentioned at the outset, lie in the huge diversity that India has imbibed over centuries in the social, economic and cultural terrain, shared and sustained by its people.

Indigenous traditions of learning mathematics

Such diversity as sustained by the people in the spheres of production and culture in varied ecosystems and landscapes is evident in traditions of knowledge and processes of their transmission. Indigenous traditions of education is one sphere where we can recognize such a tremendous diversity in the material and cultural practices of the people. India had a very rich and widespread culture of institutional education during the precolonial era, both for elementary as well as higher branches of learning. While the elementary institutions of learning were known as *pathshalas*, the higher institutions were known as '*tols*', akin to colleges. There were also *madrasas*, seats of Arabic learning. Dharampal's work has shown us that they were widespread, dynamic institutions of learning, which pervaded the entire Indian rural and urban landscape in the precolonial era (Dharampal, 1983). The *pathshalas* were elementary schools of a locality. These were single teacher schools, for a village or a group of villages, which catered to the upper and the intermediate caste groups, and excluded the lower/manual labouring caste groups. The children were divided into classes not with respect to age, but in accordance with their capability to learn language and arithmetic. There was no standardized curriculum across regions and its orientation was thoroughly local. The idea was not to produce scholars, but to enable students to study further to become one, if they chose to. The *pathshalas* were integral to the material and social world of the people.

The unique feature of *pathshalas* was the strong element of functionality in the curriculum probably a result of their complete dependence on local patronage of the community with its caste hierarchy (Radhakrishnan, 1990). These *pathshalas* were open to male children across occupational groups. They were trained in reading, writing and arithmetic (Basu, 1982; Acharya, 1996). The locus for the curriculum came from the need of the community to enable children to become competent/skilled participants in the transactions of letters and numbers within the local society. At the same time, it was also a culture of learning that celebrated exposition of skills and competence in public. Acquisition of skills through learning in the *pathshalas* over a period of four to five years continuously involved the participation of the local public in the affairs of learning, which not only patronized the teacher through economic support but also evaluated his labour (and the teacher was typically male). This meant that learning had to address local concerns of relevance. While the local orientation of the curriculum rendered such diversity to the *pathshalas* in the various regions of the country, the character, competence and the learnedness of the teacher also added to this diversity within regions–sometimes within the same village or the town. This is particularly so in the case of learning languages in the *pathshalas* where the basic objective of learning to read and write correctly was often accompanied by encouraging familiarity with certain texts either popular in the region or due to the choice of the individual teacher. This feature of a certain autonomy in what counted as learning within the *pathshalas* had to contend with a strong evaluative participation of the local public that often tested what was perceived as functional or relevant learning. But its autonomy also rendered to these institutions certain possibilities to transcend the local.

Along with diversity in curriculum, the *pathshalas* seemed to share a culture of pedagogy grounded in a form of memory very different from the modern associations of memory with rote or mechanical mode. This could be characterized as *recollective memory* where memory practices constituted a distinct mode of learning and not merely aids to learning. Oral recitations were central to this form of learning while the role of writing was to assist recollective memory, making the distinction between the oral and the written ambiguous. Learning under the aegis of recollective memory in itself constituted understanding, especially in a culture that appreciated exposition and celebrated remembering. Learning arithmetic in this mode cultivated computational abilities that often attracted attention among visitors so much so that it became common to characterize Indians as having a natural proclivity towards computation: “the natives of India are remarkable for the facility with which they acquire the mathematics; and indeed they excel in anything in which figures or numbers are concerned. Their system of arithmetic is almost entirely committed to memory and the power which the little schoolboys display in mental arithmetic is quite astonishing to the European” (Rhenius, 1841, p. 269-70). Jean Baptiste Tavernier traveling in 1665 mentions the quick abilities of Indians to sum and perform mental calculations. Remarks such as “the Banias, by the strength of his brain only, will sum up his accounts with equal exactness and quicker dispatch than the readiest Arithmetician can with his pen” are not uncommon even during the initial days of the British presence in India. The East India Company offered rewards (twenty pounds!) to its soldiers if they would learn arithmetic from the natives (Sarma, 1997).

The probable basis for such perceptions could be reconstructed from the pedagogic practice of the *pathshalas*. The dominant presence of the various number tables in the curriculum of the *pathshalas* in the various languages and region of the country are yet to be studied properly, while there remain scattered hints and reticent guesses about their plausible role in the learning of arithmetic in the past. But their integral place in the curriculum of the widespread *pathshalas* could be discerned from various sources. The Bombay Gazetteer mentioned,

> “...the vania boy commits to memory a number of very elaborate tables. These tables of which there are no fewer than twenty contain among others two sets for whole numbers, one table of units up to ten multiplied to as high as forty times; the other for numbers eleven to twenty multiplied by eleven to twenty times. There are fraction tables giving the results of multiplying $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, $1\frac{3}{4}$, $2\frac{1}{2}$ and $1\frac{1}{2}$ into units from one to one hundred; interest tables showing the monthly rate of one percent on sums from Re. 1 to Rs. 1000, the amount due for each quarter of a month; tables of squares of all numbers from one to 100 and a set of technical rules for finding the price of a part from the price of the whole” (Sarma, 1997).

D. D. Kosambi (1962), the historian-mathematician, mentioned the use of such tables in the Marathi speaking region after the name of Hemadri, who was Chancellor of exchequer under the last Yadavas of Devagiri in the thirteenth century and was an outstanding practitioner of computations. John Taylor of the Bombay Medical Establishment, who translated Lilavati from Sanskrit in the year 1816, mentions that in the Marathi schools the tables of multiplication consisted in multiplying ten numbers as far as 30 and in the Gujarati schools, in multiplying ten numbers as far as one hundred. In Bengal, *Subhankara* was an household name for the repository of mathematical or computational expertise as Lal Behari Dey writing about the life of the Bengali peasant writes, “the village school master was the first mathematician of the village. He had not only *Subhankara*, Indian cocker at his fingertips but was acquainted with the elements of *vijaganita* or Algebra”. Even in the Hindi speaking areas of the country it was a common practice to learn multiplication tables and the scholar Sudhakara Dwivedi traces the Hindi word ‘pahara’, which denotes multiplication tables to the famous poet Tulsidas who has this profound metaphor of table nine – the sum of digits in each multiple of nine is always nine; just as nine is inherent in all its multiples, so is the Lord Rama ever present (Sarma, 1997).

Along with such scattered evidence that point to a certain basis for cultivation of recollective memory with respect to the learning of numbers, there are four distinct aspects that further point towards a dynamic culture of engagement with transmission of mathematical knowledge in the Indian past. They are i) math tables which could have been manuals used in the *pathshalas* in the different regional languages ii) compilations of mathematical techniques in regional languages iii) various forms of problem posing and problem solving in popular consciousness and iv) certain kinds of practices inherent to various occupational or artisanal groups. In the following, we shall attempt to reconstruct the *pathshala* learning based on these four different types of evidence available to us.

Mathematical tables

The early nineteenth century British surveys on Indian education to the extent that they paid attention to the curriculum and pedagogy of the indigenous institutions of learning have pointed out how integral the use of math tables of various kinds were in the teaching and learning of elementary arithmetic. The study of such tables in the Tamil speaking region of the country where the *pathshalas* were called the *tinnai* schools (veranda schools or the pyal schools as the British called them) shows that the structure and organization of these tables were mnemonic in nature, whose primary purpose was to cultivate recollective memory. There is a strong pedagogic basis to their very organization and they are not textbooks in the modern sense. But they are products of learning, from within the tinnai arithmetic practice. During the process of memorizing the arithmetic tables, students wrote their own manuals, almost as an end product of their training. Drawing upon our study (Senthil Babu, 2007), we briefly discuss some of the salient features of the Tamil system to point out certain possibilities for further studies in the other regional language traditions.

Every number in the primary number series would be memorized in a particular order, in the pattern of integrating the sound of the number name, visual recognition of the symbol, loud recital and writing, with concurrent testing at each level by the monitor or the teacher. This elementary number series consisted of both whole numbers and an extensive system of fractions in the Tamil system. Such an extensive system of fractions, when represented as addition-based iterations, became the organizing basis to learn numbers in the memory mode of learning. There were separate sessions in the *tinnai* routine, where the children would stand up and recite the entire series in unison, loudly in front of the teacher, one series after the other, repeatedly, day after day till the logic of addition as the basis of number organization is cognitively internalized along with the process of building memory registers for the numbers in a particular order. This would mark the the memory learning of the elementary number series in Tamil called the *Ponnilakkam*, (*pon* = gold; *ilakkam* = number place, in the literal sense), denoting a particular order of numbers, as quantities. Next in line is the *Nellilakkam* (*nel* = paddy; *ilakkam* – number place) which is a number series that takes the units of Tamil volumetric measures as numbers and proceeds along similar lines as that of the *Ponnilakkam*. Here, the standard numbers that occur in the series are the standard units for grain measures in Tamil. This series was also organized on the principle of iterations of addition, where the basic unit of grain measure, the *cevitu* becomes the number to be added repeatedly till the highest unit, the *kalam* is reached. The standard units of the grain measure, that occur on the way from *cevitu* to *kalam* are *cevitu, alakku, ulakku, uri, nali, kuruni, patakku, tuni and kalam*. In a similar pattern, all these units that occur below the unit *kalam* would be represented in combinations with each other, paired by addition. Although there is no information for the time taken by a student to become proficient in *Ponnilakkam* and *Nellilakkam*, it seems that this alone took about two years to complete. Each student, after completely committing to memory the entire series of the *Ponnilakkam* and *Nellilakkam*, would actually write his own book on palm leaves, out of his own memory, without assistance from the teacher or the monitor. This also marks a process by which natural memory ability was trained into a cultivated memory, where reading and writing were only incidental to the learning process, not ends in themselves (Carruthers, 1990, p.70).

Followed by this was the learning of the Tamil multiplication table book called the *Encuvati*. The *Encuvati* is a compilation of several kinds of multiplication tables. All the numbers learnt during the course of *Ponnilakkam* and *Nellilakkam* would be subjected to multiplication with each other, to yield an entire set of tables, that were to be committed to memory. The organizing basis of the *Encuvati* was multiplication, represented in a tabular format, which helped secure an order, helping memory. There are several layers of multiplication tables involved. Followed by this is the learning of squares, called the *Kulimattu*. Representations in tabular order further assist recollection, allowing the possibility of identifying a median (one easy number in the middle of a table, say five, fifty, five hundred) so that both sides from that point could be remembered and recollected. Even though logical constructions involving numbers of this order are universal, (in contrast to words, that require habit and repeated practice for recollective memory), in the pedagogic practice of the *Encuvati*, we find a situation where language plays a central role, integrating itself strongly to number learning, when not a single number name would appear strange to a child growing up in a community which thrived in production and exchange practices that involved multiple modes of measurement as integral to their material culture.

Cultivating a culture of problem solving

The *Encuvati* learning sessions involved regular afternoon sessions of problem posing and solving in the *tinnai* schools. Here, recollective memory would have to score well in an algorithmic context. The students carried back problems to their homes, where problem solving happened in a non-institutional context, entirely orally to aid the process of strengthening the cognitive apparatus of associative memory. The next morning, the results were collected and discussed. The school and its pedagogic strategies were immersed in the cultural context, imbued with shared learning, where creativity in a child was associated with a whole set of agents outside the institution. This mode of public involvement points to a culture of learning arithmetic where a common pool of problems with variations in techniques was shared by both the students and the local people. This culture of learning also constituted the basis on which the public evaluated and participated in affairs of learning (Senthil Babu, 2007, pp. 28-30).

Mathematics in the regions

There has yet been no systematic attempt in documenting the various sources which would provide us clues about the nature of the problems from this common pool, which survive as remnants of the arithmetic learning culture of the *pathshalas* in various parts of the country. One such significant repository lies in the various compilations of mathematical problems in the regional languages. It requires a great deal of disciplinary labour and conviction to initiate documentation of the regional mathematical traditions and to engage with them with the rigorous attention that they deserve, while at the same time understanding the historiographical and political processes associated with the lack of engagement with this tradition so far. Though it has been recently stated that the relationship between the regional and the so called pan-Indian Sanskritic tradition of mathematics was mutual and complementary (Sarma, 2011, p. 202), there is still a long way to go before attempting any such characterization about the relationship between the multiple-regional and the canonical 'Indian mathematical tradition'.

S. R. Sarma (2011) in a recent initiative has attempted to document certain evidence regarding the presence of various such 'regional literature' of mathematics. He points to the close association between the professional scribal communities like the *kayasthas* in Northern India and the *karanams* in the south and the merchant communities of western India. In the eastern region, Orissa seems to have a rich heritage of mathematical treatises, like the *Lilavatisutra* which was a very popular text in Orissa for all age groups to study mathematics through works of addition, subtraction, multiplication, division, mensuration, trigonometry and so on. The diversity and variations in the regional corpus of this tradition was also due to the fact that there were such enormously diverse systems of metrological practices in various regions, and often within the same region speaking a single language. Sarma states that even if some of such regional texts could be translations from the prevalent Sanskrit texts like in the case of *Ganitasarakaumidi* composed by Thakkur Pheru, a learned Jaina assay master at the court of Khaliji Sultans, which was almost a phonetic translation of Sridhara's *patiganita*, the examples in the regional literature were drawn from the different localized professions involving traders, carpenters, masons. Sections on solid geometry contained rules for calculating volumes of bridges, crop yields and magic squares. *Kayasthas* in the northern region who were professional record keepers had their variety of arithmetic called '*kaitheli Amka'* in verse form, which was published as '*Kautuk Aru Kaitheli Amka'*. Even in the case of texts of non-professional genre like the *Pavuluruganitamu* in Telugu which seems to have been a translation of Mahavira's *Ganitasarasangraha* by Mallana in the eleventh century, there are interesting variations. If *Ganitasara* had five methods of squaring and seven methods of cubing, Mallana had only one each and avoided the algebraic route. In case of examples, more interestingly, there are forty five additional examples under multiplication and twenty one in case of division that are not found in the Sanskrit source.

In the Tamil speaking region, in texts of the *Kanakkatikaram* corpus the local world of transactions remain as the focus, though the handling of arithmetic was more advanced from the primers in the enumeration of rule of three, magic squares, exhaustion problems, recursions and partitions. In a typical *Kanakkatikaram* text we have at least six distinct sections, classified according to the objects of computation. These texts primarily set out the rules of computation using different techniques. Normally, they are found to have sixty types or '*inam*' (in the sense of a 'genre') in as many verses. These verses enumerate techniques involving various kinds of measures related to land, gold, grain, solid stones, volumetric measures and a general section. For example, the section on land would deal with various ways to measure area of land of different dimensions, in both whole and fractional magnitude; estimation of total produce from a given area of land; assessment of yields, profit and so on. The section on gold would deal with computations related to estimation of quality of gold, calculation of price and combinations of mixture in the making of particular grades of gold. Since gold was also a unit of money, this section would deal with computations involved in transactions of money involving goods and labour. Verses dealing with grains for example would deal with techniques of conversion of measures, profit and loss calculations.

In a social sense, all such arithmetic representation with embedded cognitive aspirations, are characterized by a yearning to enable a person to be in control of a situation, to plan, estimate, assess and anticipate. Yet, the occasions were the normal day to day socioeconomic transactions (Kameswaran, 1998). However this was not specialized knowledge for specialists or for training specialists, even though there was constant yearning to move beyond the functional into realms of the fantastic. This further invokes a sense of how such prowess in computations was meant for public exposition, for display and for performance with a system of virtues associated with such abilities, imbibed in the *pathshala* practice of teaching and learning arithmetic (Subramaniam & Kameswaran, 1999).

Mathematics among the people

It is still not uncommon to find in several parts of the country, especially in rural areas, the circulation of mathematical problems as riddles and aphorisms among the people. The correspondence between what exists in the memory of the people, in certain realms of popular consciousness and their variants in the prosodic form recorded in texts is yet to be studied. However it does point to a common shared culture of problem solving among people. Such problems are often termed as recreational problems and there have been recent attempts to document them across cultures using classical texts of mathematics like that of Aryabhata (Singmaster, 2000).

The regional traditions of mathematics survive beyond the realm of texts with constantly changing variations over time, in particular with respect to the use of examples where one could also discern instances of social critique and satire. For instance, S. R. Sarma records a riddle from rural Andhra Pradesh which implicitly brings up the image of the 'clever' Brahmin, an image that is not too uncommon in parts of rural India.

> "15 Brahmins and 15 thieves had to spend a dark night in an isolated temple of Durga. The Goddess appeared in person at midnight and wanted to devour exactly 15 persons, since she was hungry. The thieves suggested that she consume all the 15 plump Brahmins. But the clever Brahmins proposed that all the 30 would stand in a circle and that Durga should eat each ninth person. Brahmins arranged themselves and the thieves in a circle...Durga counted out each ninth person and devoured him. When the 15 were eaten, she was satiated and disappeared, and only the Brahmins remained in the circle" (Sarma, 2011).

The problem was how did the Brahmins arrange themselves with the thieves in the circle? This riddle was also composed as a Telugu verse in a classical meter.

There are other varieties of riddles in the folklore. For example, a Bengali tribal woman not used to taking her husband's name when asked to provide the name of her husband, which was *shait*, meaning sixty in a dialect in Bengali would recite it as:

Tin tero diya barao
Noi diya milani karo
Mor soamir namiti aei
Par kore dao barit jai

This means if you multiply the number three by thirteen and add twelve and nine with the result, you see the answer is simply '*shait*', that is sixty. Or in the case of another example where children playing together count the number of players among themselves by reciting rhymes, where each word represents a particular number:

Yakor byakor tyakor shail
Kail porshu mongol bar
Kari gone majumdar
Dhaner aga naler shish
Khata doba unish bish

Here the word *yakor* represents the number one, *byakor* two and so on till *bish* meaning twenty (Sinha, 1995, p. 99). As recent as 2007-2008, field work in the Kaveri delta area in the coastal district of Nagapattinam in the state of Tamil Nadu provided an opportunity to record some of the riddles prevalent among the older generation in the villages, which interestingly are very similar to the kind of problems found in the *Kanakkatikarm* texts, discussed briefly above. The examples and the context have obviously has been changing over time, as can be noticed with the appearance of the cyclist in the following story:

> An old woman carried a basket full of lemons to sell in a nearby market. Then a person by accident hit her with his bicycle and all the lemons spilled out in all directions. The cyclist gathered all the lemons in the basket and asked the old woman, "how many lemons were you carrying in your basket?" She said, I am not sure about the total number of lemons, but I know one thing for sure. If I grouped the lemons in twos, one will be left behind. If done in threes, one will be left; if grouped in fours, one will be left; if grouped in fives, one will be left; if grouped in sixes, one will be left and if grouped in sevens nothing will be left behind. The cyclist replied, oh, in that case, I have gathered all the lemons you brought into the basket without a mistake and he left. How many lemons were there in the basket? (Answer 301) (Senthil Babu, 2008)

In the following example as well, one can see signs of these riddles changing examples and characters whereas the nature of the problem remain the same, pointing to the dynamic nature of transmission among people and strands of continuity in popular consciousness over time.

> A father had three children. Each one of them had some money and so did the father. One day, he called his eldest son, took the money that his son had, and put in the same amount from his own pocket. Out of the total money, he bought 4 rupees worth of books. Then he called his second son, showed him the remaining money he had, got the same amount from his second son, and bought 4 rupees worth of books for his second son as well. Then he called his third son, showed him the remaining amount, got the same amount from the son and bought four rupees worth of books for the third son as well. At the end of it all, he did not have a penny left with him. If that is so, how much did the father have in the beginning?

or in this case, it is more evident:

> A person went abroad and returned home after three years. A friend of his met him incidentally and asked, "How many passengers were in the ship when you traveled?" The person gave him this funny answer: Us, along with the same number as 'us', half of us, and half of that and yourself would make a 100 passengers. How many were there in the ship? (Answer: 36). (Senthil Babu, 2008)

Mathematics and work

Another realm that testifies to forms of transmission in the indigenous tradition is the one through work, involving artisanal communities and specialized craftsmen like carpenters, sculptors, goldsmiths, etc. Though the practice of apprenticeship in the various crafts and artisanal work varies with the nature of the profession and the community, the nature of the mathematical engagement in such work involves learning on the job. There are several texts which are like manuals for certain crafts both in the regional language traditions as well as in Sanskrit, from the past. There are very few individuals who could situate and understand the content of these texts but the fact that forms of these crafts and arts continue to thrive points to the strong ways in which forms of learning and knowledge transmission happen at work. Traditional stone and wood sculptors in south India, the bronze sculptors of Swamimalai in Tanjore, artisanal workers like the carpenters and blacksmiths are certain groups which continue to operate and transmit specialized knowledge through work. Detailed anthropological studies on these communities and their way of work and learning as a continuous process are yet to be undertaken in the country. There have been recent attempts to initiate such studies as in the case of boat makers in West Bengal. These boat makers employ traditional techniques, build large – 50-60 feet in length – deep-sea fishing boats. Most of them have had very little schooling and cannot read or write. They work with minimal tools and without a blueprint (Mukhopadhyay, 2011).

The social context in which such varied forms of circulation and transmission happened was however ridden with deep hierarchies, primarily determined by caste. The pathshala culture was not aloof from this. Extreme forms of labour servitude, spatial segregation and social discrimination against the oppressed caste groups meant institutionalized forms of denial in access to education. But the functionality centered curriculum of the *pathshalas* and the *tinnai* schools was also a means to control labour by appropriating labouring practices as legitimate knowledge that the youth from upper castes should be trained in. The majority of the labouring and oppressed caste groups without access to institutional education like the pathshalas however have always remained familiar with the world of arithmetic practices – counting, weighing, measuring, estimation, assessment, etc., in their realms of work in primary production and services in agrarian and mercantile practices. The cultural context lacked a common culture of learning and discovery where young learners from all backgrounds could sit and learn together. The constitution and reproduction of knowledge in the culture involved a process of exclusion. In the process, institutions such as the pathshalas were deprived of a much enriched engagement with work, knowledge and culture of all sections of the people in the local society.

Mathematics in *'tols'*

This brings us to another set of institutions in the indigenous tradition, which were centres of higher learning reserved exclusively for the upper caste Brahmins. There was no graduated system of learning from the pathshalas into these Sanskrit colleges, called '*tols*'. They were independent institutions, where the pathshalas were meant for the trading and agricultural classes and the tols for the "religious and the learned classes" (Basu, 1982, p. 32). In these institutions both the teachers and the students were Brahmins where theology, metaphysics, ethics, law, astronomy, logic and medicine were taught. Such institutions were supported by different forms of patronage of the ruling classes, often through land grants of different kinds (Dharampal, 1983, p. 30-32; Basu, 1982, p. 32). These were again institutions that were widespread in different parts of the country, in Bengal, Deccan and the Southern regions in particular, with highly specialized centres of learning like Benaras, Nadia, etc. which attracted students from all over the country. These institutions were often closely related to temples and monasteries and their focus varied according to the region and sect.

These centres of learning seemed to have preoccupied themselves with the study of logic and computational astronomy, with respect to the learning of mathematics. It was an entirely different kind of engagement that probably demanded very different ways of organizing mathematical techniques like a predominant concern with the algebraic mode. But this was a tradition that had its ups and downs depending on the fortunes of the patronage on which the institutions were entirely dependent. Nevertheless there was a continuity in the tradition and this could have constituted the basis for what became a canonical tradition of 'Indian mathematics', in which the primary means of transmission as oral or written within the canonical tradition remains an open issue among historians of Indian mathematics (Yano, 2006; Filliozat, 2004). But locally, this tradition in its various forms also served well in feeding into a sustained ritual function and status of a community whose social roles were integral to the social order.

Along with the *tols*, there were also centres of Arabic learning where Persian was the medium of instruction for it was the language of the court in most parts of the country, as in Bengal. The Arabic schools in particular taught "numerous grammatical works, exhaustive courses of reading on rhetoric, logic and law, a detailed study of the external observances and fundamental doctrines of Islam; Euclid and Ptolemy in translation were not unknown; there were also courses in metaphysics and natural philosophy" (Basu, 1982, p. 32-33). At a larger level, the entire complex of indigenous educational tradition seemed to have taken on the function to 'conserve custom, to organize and sanction the existing political and economic order and to provide philosophical and religious enlightenment to the ruling classes' (Basu, 1982, p. 33).

The colonial encounter

This entire tradition of indigenous education came into contact with the colonial project of the British primarily through the early Christian missionary societies like the Tranquebar educational experiments and the Schwartz's schools in Tanjore, Ramnad and Shivganga in the 1770s and 1780s. The Baptist missionaries Carey, Marshman and Ward at Serampore, the London Missionary Society and the American Methodists in Bombay were the early agencies (Basu, 1982, p. 4) to engage with the *pathshalas* and the *tols* through the process of making education as a means of missionary work in the colony. These, along with the early, hesitant attempts of the emerging company state, gave rise to some of the early critics of the indigenous educational tradition, who reframed the ethos of recollective memory of the *pathshala* pedagogy into that of mechanical memory, or rote memory. The early educational surveys in the provinces of Madras, Bombay and Calcutta and later in the Punjab not only enumerated the *pathshalas* by counting and classification but in the process constituted an 'Indian indigenous education' divesting the sheer diversity of the curricular practices inherent to the *pathshala* practice in the different regions of the country. Robbing them of their diversity and spontaneity (Acharya, 1996) and branding them as 'rote' institutions, they sealed the functionality of the *pathshalas* from within.

The erasure of the curricular diversity in the *pathshalas* was also conditioned by the necessities of founding a revenue establishment, which hitherto had no semblance of homogeneity across different regions. Standardization of assessment practices in the revenue administration and state building together with the political imperative of sticking to a liberal rhetoric of a 'civilizing mission' meant that there were always contending ideals of functionality in establishing a modern education apparatus in a colony. The former required a 'recruitable public' which meant a definite notion of functionality in education that would yield a cadre of highly useful, functional men to serve the state. The latter although apparently wanted to free education from any functionality to cultivate liberal minds through the process of the grand imperial civilizing mission ended up serving the former agenda. One of the most ironic aspects of this legacy unfolded in the early nineteenth century when the colonial project in the name of dislodging mechanical memory from the *pathshala* practice did exactly the reverse by bringing it right in to the centre of learning. The institutionalization of this new functionality also tied education with employment changing hitherto local-public evaluation into a new machinery of impersonal, objective and very private, individual mode of evaluation bringing to the fore definite ideas of merit and capability in a highly hierarchical societal order.

The detailed processes by which these aspects played out in the different provinces in the case of the teaching and learning of mathematics right through the nineteenth century awaits the attention of scholars. There are a few studies that we could rely on to provide us with some picture about the developments in the different provinces. In the early decades of the nineteenth century, colonial intervention in education was ridden with ambivalence towards what was characterized as oriental learning and the initiatives under what came to be known as public instruction involved a strategy of 'tactical accommodation' of components of the indigenous education. For example in the Poona Sanskrit College traditional subjects like *jyotish*, *vedant*, *ayurveda*, *Nyaya*, *Dharmshastra,* etc., were taught to 'maintain a goodwill among the Hindus'. In Calcutta

Sanskrit college students were required to study mathematics through Indian classical texts. The mathematics contained in these texts were deemed to be 'very ingenious', yet inferior to European mathematics, while in the same institutions the Sanskrit translation of Hutton's mathematics was also used in the classroom, so that the 'students will be exposed to their own sciences along with a more advanced one' (Tiwari, 2006, p.1270). In the case of pathshalas too, in Madras presidency in Thomas Munro's first scheme to intervene in indigenous education, modern European sciences were taught at the district level Collectorate institutions, whereas the '*tinnai* curriculum', especially the *Encuvati* was retained in the *tashildari* schools established by the company administration.

There were also several concurrent teaching experiments as in the case of the Benaras Sanskrit college where *Nyaya* was taught along with European way of studying logic. Another instructor, Pandit Bapu Deva also taught astronomy, mathematics and mechanics. In fact, there was an institution for village schoolmasters - the *pathshala* teachers, at the Benaras college with an aim to introduce both European knowledge as well as Hindu texts used in the village and the teshil schools. This probably led to a phenomenon centred in Benaras where several works in Western mathematics and astronomy were written in Hindi and Sanskrit by the pandits of Benaras even during the second half of the nineteenth century (Tiwari, 2006, p.1274).

But the most interesting feature in the early initiatives in education at the beginning of the nineteenth century was in the realm of pedagogic innovations that were developed through a process of transmission involving the colony and Europe simultaneously (Tschurenev, 2008). One such innovation was the monitorial system of education. We provide a brief account of this process of transmission using the south Indian case involving the *tinnai* schools and the manner in which the missionaries engaged with them. The important features of the missionary engagement with the *tinnai* were, their negotiation with the local necessities of legitimacy and credibility, bargaining with the company administration to provide leverage in employment for their students and setting up their strategies of teaching and learning conditioned by these features. More importantly they were inadvertently carriers of a system of pedagogy, blessed by the Episcopal authority of the English church, which during the early decades of the nineteenth century was still the dominant player in elementary education in the whole of England. Here is the story of a system of pedagogic knowledge, which traveled from India, became one of the primary means to popularize elementary education in England, and came back to India, all along, going through continuous attempts at modification and improvement. This was called the Madras System of Education, or even sometimes the Malabar school system.

The Bell – Lancaster pedagogy and the *pathshalas*

Rev. Andrew Bell was the company chaplain in the Egmore Male Asylum in Madras in South India, during 1789-96. During his tenure, he encountered, or rather, discovered the *tinnai* pedagogy during one of his morning rides. Even though the available accounts in England make it out as a dramatic discovery of writing on sand (for reasons of economy) and for its monitorial system, in effect, Rev. Bell did two things:

- The actual working of the *tinnai* pedagogy was reframed into a set of principles based on Christian value system
- Internally, the memory mode of learning in the *tinnai*, using mutual instruction was reconstructed with respect to reading, writing and arithmetic, the three R's, as perceived in England.

Bell practiced his experiments in the Egmore asylum till he left for England in 1797, where he published his book on the Madras system in the same year. His arithmetic pedagogy, as spelt out in his book had very close resemblance to the *Encuvati* mode of learning in the *tinnai* schools. Every number had to be resolved into its component parts, which are simply half periods, consisting alternately of units and thousands. With respect to the four cardinal operations, he said, let the elementary parts be perfectly learned in classes of short, easy and frequent lessons, repeated as often as necessary. But before proceeding to actual operations, make the learning of tables perfect, so that, students could themselves construct addition, subtraction tables along with multiplication and division.

There ensued a major controversy between Bell and Joseph Lancaster, a dissenter and a Quaker, who claimed to have invented the monitorial system of education independently. The entire affair turned out be messy and engaged several levels of arbitration, including the Church of England and the Princess of Wales (Salmon, 1932). Without going much into the details of the controversy, the various missionary experiments in the first half of the nineteenth century in south India came up with a system of arithmetic teaching whose salient features were:

1. Plan of mutual instruction with monitors guiding the students
2. Memory and its practice central in reading and arithmetic, with loud recital, simultaneous vocalization and visualization while writing
3. Memorization began with the writing down of figures in sand tables
4. Centrality of tables, with the difference being (in relation to tinnai) that the four operations of arithmetic taught in relation to each other by simultaneous construction of addition and subtraction tables, and multiplication and division tables

5. Memorization proceeded along with the construction of tables
6. Memory tested step by step by the monitor during the construction of the table and while associating with operations
7. The actual operations however now had to be worked out on slate, and by using columns, making the slate, the central device.
8. Keys, or guidebooks to the monitors becme essential.
9. The general plan of arithmetic teaching became standardized as: 1. Combinations of figures, 2. Addition 3. Compound Addition 4. Subtraction 5. Compound Subtraction 6. Multiplication 7. Compound Multiplication 8. Division 9. Compound Division 10. Reduction 11. Rule of Three 12. Practice
10. Emulation, rewards, steadiness of application become the normative values for students to imbibe.
11. The teaching of catechism fitted in perfectly in the monitorial and memory based system

However much the argument was against rote learning, the learning of arithmetic now proceeded by learning a given set of rules, practicing these rules followed by "reduction" (i.e., problem solving). This is in contrast to the *tinnai*, where the starting point was the learning of numeration through the *Ponnilakkam* and the *Nellilakkam* by the simultaneous construction of the number series, which would then lead to the *Encuvati*. Along with this, problem solving was trained, testing associative memory, through oral means. The pride of each student, who would create his own manual on palm leaves would come after learning numeration and the tables.

Both Bell and Lancaster provided a major impetus to the spread of popular education in England, where education had been confined to the classical learning in the public schools and the two universities for the elite whereas the poor went to the Sunday schools, which were conceived as a means to counter the emerging radicalism of the working class. William Whewell and Augustus De Morgan, in their own ways pioneered certain reforms in the field of mathematics education. For Whewell, the teaching of mathematics was indispensable to liberal education, as 'discipline of the reasoning power will enable persons to proceed with certainty and facility from fundamental principles to their consequences', wherein the best means to educate men in reasoning would be the study of mathematics. Mathematics was about reasoning by practice superior to the study of logic, which was reasoning by rule. Learning arithmetic was like fencing or riding, a practical art, cultivated by habitual exercise (Whewell, 1836). In 1831, De Morgan published his work on mathematics education, *On the Study and Difficulties of Mathematics*, as part of his initiative to reform British education from the dominant hold of the classical education scheme of the Cambridge, Oxford kind, through his London based, Society for the Diffusion of Useful Knowledge, which published new textbooks and manuals for the teaching of Arithmetic and Algebra in the 1830s. The University of London, to which he belonged was part of a political initiative to move away from the dominant Oxbridge mode of classical education for the elite. He critiqued the Bell-Lancaster system and literally lambasted the pedagogy: this system, to him, broke down arithmetic into a multitude of rules, many of them so unintelligible that they could be 'Hebrew'. Pupils were not expected to understand the reasons for rules but merely to be able to apply them. Teachers were scared to teach such principles, for to do so required knowledge and understanding. Therefore, it was much easier to teach rules and various books of worked out solutions to avoid any troublesome questions. As a result, after several years of working meaningless and useless questions by the slates-full, the student left school as a 'master of few methods, provided he knows what rule a question falls under'. According to De Morgan, Arithmetic teaching should commence with a clear explanation of methods of numeration, illustrated by reference to other systems besides the decimal and supported with the use of counters. The Bell Lancaster system condemned the majority to the rote learning of half digested gobbets of information (Howson, 2008, p. 86). In effect, memorizing the rules to carry out each case, a student would only have to recognize which case a given problem falls under and apply the appropriate rule, a game of manipulation based on matching problems to rule (Phillips, 2005, p. 105-133). But even in the 1830s, when this critique was being developed in England, its public school system was very much rooted in the classical tradition, which was meant to educate politicians, civil servants, clergy, army-men and administrators of the empire (Howson, 1981).

However, the Bell-Lancaster system came to India much earlier. The first evidence of it could be found in the noted Burdwan Plan of 1818, which was a general plan of instruction for the Indian schools under the auspices of the missionaries. Bishop Reginald Heber went on a grand Episcopal tour, with the determination to push Bell's system of education in the provinces of Bengal and Bihar. In the South, Bishop Middleton started a school under the Bell model in 1819, followed by Fr. Rhenius of the CMS in the schools of Tirunelveli around the same time. The localizing of the Bell pedagogy in South India through the missionaries, brought up a scenario where within the same Tamil missionary institution, one had the Bell system in operation, with Tamil schoolmasters; and in other sections, a different Tamil schoolmaster would be teaching Tamil arithmetic of the Encuvati mode, using palm leaves. What exactly was happening to the two modes of memory, the Bell-Lancaster mode and the tinnai mode, within the confines of the same institution, with the native schoolmasters is difficult to figure out. But the missionary strategy evolved out of this experience, which clearly stuck to 'native ciphering' in its Tamil schools, with Tamil schoolmasters till they were ready for their European arithmetic. In their English medium schools in urban centers for the landed elite, they continued to teach European arithmetic, primarily using European textbooks, which were used in the military seminaries, including Walkingame, Charles Hutton, Maclarin, etc. Among these, Hutton's Course of Mathematics was the single most influential arithmetic textbook that generations of army-men and civil servants were trained on, in the seminaries of Woolwich and the like.

Some of the mathematics school books written by the missionaries like the one by Mary and Harle in Chinsura was unanimously promoted by the early School Book Societies like the Calcutta School Book Society which also gained popularity among the Bengali *pathshala* teachers as the demand among the native schools in Bengal was for English where "students were eager to acquire account keeping skills in both the old and the new English forms of arithmetic and they wanted to practice an accurate, elegant handwriting" (Tschurenev, 2011). In the case of the Madras School Book Society the first arithmetic textbook in Tamil by Ramasamy Naicker was published which classified the learning of arithmetic under the four operations as distinct from the Tamil mode of traditional classification based on *Ponnilakkam, Nellilakkam* and the *Kulimattu*. Along with Ramasamy, there were also in active circulation, Walkingame's Arithmetic and Charles Hutton's Course of Mathematics, two volumes which themselves represented the old and the new in the British arithmetic curriculum. The Bombay Native Education Society under the leadership of Capt. George Jervis adapted several of the contemporary British textbooks like Hutton, Bonnycastle into Marathi and Gujarati textbooks and published full fledged translations of some of the English textbooks. The entire two volume Course of Mathematics by Hutton was translated by Jervis as *Shikshamalla* (Bombay Native Education Society, 1831). Through all such attempts, Notation and Numeration, the four simple rules of arithmetic, compound rules and working of problems based on the rules, the rule of three and fractions constituted the syllabus, and the elementary mathematics curriculum deviated little from this set course for the next hundred years.

By the mid nineteenth century, with the combination of the missionary engagement and the company's intervention certain features of mathematics teaching became significant. It had set the elementary arithmetic curriculum to the four simple and compound rules along with the rule of three. Though professedly against memory, in practice it seemed to have perpetuated it as wasthe case in contemporary England. Arithmetic was about memorizing tables and manipulating numbers to a set of rules. The normative values associated with arithmetic became, perseverance and steadiness of mind, which was not yet found in the Indian student. However, it was believed that the anxiety of an English education would ultimately inculcate such values in them, through the learning of modern arithmetic. The use of textbooks became integral and indispensable. Along with them, practicing problem solving in the four operations became stuck to slates, or to pen and paper, and a few genuine attempts to introduce mental arithmetic all became mere supplements to the slate. But the elementary mathematics teacher largely was on his own. It was primarily left to him to deal with these new textbooks and the new mode but with the same old Indian student, without any training or assistance. It appears that this parallel coexistence of the *pathshala* mode and the textbook centered, slate centered arithmetic was well established by the the 1850s, and nothing much changed in their respective practices for at least, the next three decades. And since then, any encounter between the Indian student with modern mathematics, in its institutional avatar, was characterized as mechanical memory.

Indian initiatives

While this process was playing itself out during the first half of the nineteenth century during the making of the colonial state, production of textbooks acquired a very important place in the sphere of negotiation between the contending ideals of mathematics education. Vedanayagam Shastri, trained under the German missionaries in Tanjore attempted to reform and rewrite the traditional Tamil *Encuvati*, the table book used in the *pathshalas* in such a way that the process of constructing arithmetic tables become transparent to the student. He called it *En Vilakkam*, meaning number explanation as opposed to *En Cuvati*, meaning number text – from the fixed static number text to the dynamic and process centred number explanation as tables. Master Ramachandra's significant pedagogic initiative in Delhi led him to deduce an alternate way of solving simple problems in calculus, as finding the maxima-minima. In his project what was normally a problem of differential calculus was "brought within the possibilities of pure algebra", a project that was nourished by algebra as a "cultural metaphor", "designed to rejuvenate and update the supposedly algebraic disposition of the Indians" (Raina and Habib, 1989, p. 2083-84).

The arena of textbooks would continue to become a site for negotiations throughout the nineteenth century, especially at the turn of the century when it became the primary means of a nationalist engagement to intervene in education. Writing textbooks in the vernacular as a nationalist endeavour involved two identifiable tendencies. There were conscious attempts to resurrect the traditional texts and to publish them without allowing any single trace of the British or the European elements to enter the textbooks, as in the case of the publication of the *Encuvati* table books in the Tamil speaking region in the 1920s in Tamil, in the various small towns. The other tendency was to look for grounds of convergence between the two traditions, while attempting to write textbooks. The famous nationalist scholar Gopal Krishna Gokhale wrote Marathi textbooks for arithmetic where he used '*upapattis'* while introducing the four operations using Marathi numerical notation through out. There were distinct changes to textbook writing practices during the turn of the century where there seemed to have been a conscious attempt to avoid fraction tables, for instance. By the 1930s, one could discern a certain standardization in the production of arithmetic textbooks into chapters organized on the basis of the four operations, omitting the compound operations and retaining the rule of three (Subramaniam & Kanhere, 2011).

Appropriating the *pathshalas*

The dominant story however from the mid nineteenth century onward was the consistent attempts by the colonial administration to convert the *pathshalas* of the various regions into modern schools, apart from parallel attempts to institute their own set of institutions teaching European sciences. The Woods Despatch of 1854 paved the way from the early filtration theory to mass education by the colonial administration resulting in the establishment of a massive educational bureaucracy with a strong inspectorate system consisting of ranks of school inspectors whose primary job was to convince the *pathshalas* to adapt to a modern curriculum. This policy of conversion in practice resulted in setting up of a colonial educational bureaucracy, heavily centralized, which sought to extend its control right into the classroom. Textbooks became the vital medium of this control and curriculum prescription for eligibility of grant in aid, the guiding frame of authority. Minimal enrolment forced innovations within the grant in aid, on a continuous basis, like the salary grants system, the payment by results system or the combined system of both salary and results, all meant to convert the *pathshalas* into the modern fold (Shahidullah, 1996).

The *pathshalas* however survived undisturbed, but for a few towns where the inspectors would reach in their extensive tours (provided it was an upper caste neighborhood), where the village elite (often of the same caste as that of the inspector) would determine the possibility (or otherwise) of the school to convert (Senthil Babu, 2011). An entire series of public examinations in the colonial state's consistent effort to create a recruitable public came to be instituted from the early 1840s, which was also modeled on the British tests for civil services. These texts with their rigid prescription of the curriculum had a crucial role in the making of the first generation of educated middle class. But the mass production of qualified people for government jobs had to be soon kept under check, which resulted in further grades of public examinations and high rates of failure.

Within about ten years of the grant in aid experience, concerns were raised about the curriculum from various quarters, primarily led by the missionaries. The curriculum was too difficult for an age group of 7-15, with the movement of one grade to another now entirely decided on the basis of written examination rather than a scheme of 'liberal' education, as the British intelligentsia in the metropolis imagined. The rule of textbooks consolidated itself: it was just that you had vernacular translations of English textbooks instead of writing new textbooks as seen in the early period. Colenso, Barnard Smith and Bradshaw were the three arithmetic textbooks that were in contention, and repeated offers were made for better translations. Already by the 1870s, a well formulated critique of the curriculum, examinations and the rule of textbooks evolved and the most significant evil was found to be mechanical memory.

Assimilating the *pathshalas*

Evidence was collected from several members involved in the business of education during the Education Commission of 1881, popularly known as the Hunter commission which gave its Report in 1882. Various representatives who presented their views to the commission, across ideological and caste equations, argued for the inclusion of the *pathshala* arithmetic into the official grant in aid regime, if the government was at all serious about expansion of elementary education. In case of Madras where we have examined in detail the process of the engagement with the *tinnai* schools, scrutiny of the various arguments in the Education Commission reveal interesting arguments about the *tinnai* arithmetic curriculum. The results grant system, aimed mainly at the elementary schools, they argued, would only succeed, if the *tinnai* arithmetic becomes part of the official curriculum. And suddenly, in the submissions to the commission, arguments about relevance of the curriculum to local contexts, the necessity of skills to enable children for better participation in life, that education should also be for purpose of life and not merely for promotion of higher standards or for employment - were all voiced during the committee's proceedings. The tinnai master's proficiency in that mode of arithmetic was recounted, celebrated, almost with a sense of nostalgia. Ironically, this nostalgia came not from the educational establishment but from the employers: the railways, the chambers of commerce, the banks, revenue, public works–in short the employers were lamenting how the first generation of employees who came out of the traditional system of education were so efficient in all trades, especially in book keeping and mathematics. They lamented that "the present generation of high school and middle school graduates despite going through the grind of multiple public examinations, which do help in providing certification for us to employ on public standards, can't do simple addition properly" (Evidence, 1882). Others went to the extent of arguing that the British better realize that they are dealing with a complex civilization which the indigenous society is; they just cannot do with a cut and dried curriculum, imposed from without catering to the varied wants of an entire country; all one could innovate upon were 'refined ways of torture' in the name of examinations and evaluation and so on. There were also strong arguments that the community should decide the course of instruction. The Principal of the Presidency College of Madras, Mr. Duncan explicitly stated that the business of teaching deductive logic and arithmetic should be left to the natives as they were good at it (Evidence, 1882).

The result of such arguments in the various provinces due to the Education Commission reflected in several policy measures on the part of the colonial state in the last decades of the nineteenth century. The specific ways in which they figured in practice in the *pathshalas* and other kinds of elementary institutions awaits detailed study. However in the case of Madras presidency, there was a clear shift in coming to terms with the resilient traditional institutions by consciously trying to assimilate elements of their curriculum into the official mode. The traditional arithmetic now got assimilated into the official curriculum as 'mental arithmetic' along with slate centered practice of learning the four basic arithmetic operations and the rule of three. The tables of the *Encuvati* now became part of the new textbooks including the conversion tables of the various weights and measures into the modern English measures, while the use of Tamil numerical notation was entirely done away with. Rechristened now as 'bazaar mathematics', mental arithmetic became a regular adjunct to the rule based problem solving in practice and reduction. It was not recollective memory as the very mode of learning. Memorization was not trained and honed as interpretation. Memorization became an aid in learning arithmetic. It was not prudence that was the preferred virtue as in the case of *tinnai* arithmetic, but speed and diligent following of rules that would get results, became the normative value for students to imbibe.

The state monopoly over publishing textbooks was given up in favour of private enterprise, which resulted in a flourishing native textbook market bringing in a new generation of clerical and teaching professionals as textbook writers. They only had to follow the grant in aid based guidelines while attempting to write new textbooks. The grant in aid guidelines now also integrated public service examinations with the school curriculum by assigning portions to be covered in various subjects for particular examinations, as shown in Table 1 below. Along with generating a new culture of arithmetic practice attuned to the now well set mode of examination centered evaluation for the sake of employment, rather than for the sake of a general education, a new mode of functionality became institutionalized in the learning of elementary arithmetic by the turn of the century. This also in many ways sealed off the school arithmetic curriculum and pedagogy from various modes of learning and engagement with the world of arithmetic outside the school.

In this process, a curriculum of arithmetic mixed enough to make it legitimate in front of the local public along with some space for the rural schoolmaster to teach came into being. But the rate of failures was increasing in various examinations and the number of drop-outs in them were on the rise. The increasingly visible and vocal Indian intelligentsia, thanks to the emerging print world, started talking about the tyranny of exams, the rule of textbooks and growing unemployment leaving a lasting legacy of issues in the sphere of elementary teaching of mathematics for subsequent decades.

Table 1: Arithmetic Curriculum in Madras Presidency, 1881 (Evidence, 1882)

Name of the examination	Class and Marks	Arithmetic Standards Required
The Higher Examination for Women	Compulsory; Maximum 90 and Minimum 30	The four simple and compound rules, reduction, vulgar and decimal fractions, simple and compound proportion, practice, extraction of square root, interest

	Optional (Mathematics); Max 80 and Min 20	Euclid – The first two books with easy deductions Algebra – Addition, Subtraction, Multiplication, Division, Involution and evolution of algebraic quantities and simple equations with easy deductions
The Special Upper Primary Examination	Compulsory; Max 80 and Min 26	Four simple and compound rules, reduction and vulgar fractions *(English figures must be used, and the candidate must be acquainted with the principal Indian weights and measures)*
Examinations under the Results system	First (Lowest Standard); Max 16	Notation and Numeration to four places of figures, Simple addition of numbers of four figures in five lines. (*English figures must be used in this as well as in the higher standards)*
	Second Standard; Max 24	Notation and Numeration to seven places of figures. Multiplication table to 12 times 16. Four simple rules
	Third Standard (Vernacular); Max 32	Easy questions in the compound rules and reduction, restricted to Indian weights and measures, and money tables published by the DPI Easy mental arithmetic restricted to the simple rules
	Fourth Standard: Max 48	Miscellaneous questions in the compound rules and reduction, easy questions in vulgar fractions Mental arithmetic applied to bazaar transaction
		In Vernacular schools the questions will bear exclusively on the Indian tables published by the DPI, *including the native multiplication table of integers and fractions marked A, and the table used in native bazaars marked B*.
	Fifth Standard, Max 56	Simple and compound rules, reduction, vulgar and decimal fractions Mental arithmetic applied to bazaar transactions
	Sixth standard; Max 48; now with the head Mathematics	Arithmetic- as for the fifth std, with the addition of Practice and Simple Proportion Euclid – Book I, to the end of the 16th proposition

The Middle School Examination (Seventh Standard)	Branch D: Arithmetic: 110 marks	The compound rules, Reduction, Vulgar and Decimal Fractions, Practice, Simple and Compound Proportion (English figures must be used and the candidate must be acquainted with the Indian weights and measures and the English tables of money, of Troy weight, of Avoirdupois weight, of Lineal, Square and Cubic measures, and of Time)
	Branch E: Mathematics, 90 marks	Euclid, Book I (50 marks) Algebra, to the end of Fractions (40 marks) Symbols permitted by the Madras University may be used.
The Upper Primary Examination	Branch B: Arithmetic (compulsory) 40 + 10	a) To work miscellaneous questions in Reduction, the Compound rules and Vulgar fractions b) Mental Arithmetic applied to bazaar transactions
Lower Primary Examination	Arithmetic, 40 marks	To work sums in the first four rules of arithmetic, simple and compound, including easy miscellaneous questions

The *pathshalas* continued to exist well into the first decades of the twentieth century independent of the colonial educational apparatus before they were rendered irrelevant or assimilated into it. Going to school and passing examinations acquired distinct yet different cultural meanings for different classes of people. Studying for employment however continued to remain a dominant concern and only strengthened over the years. The new nation state after independence was concerned with institutionalization of a modern general secular education but even a highly limited version of the idea of fundamental right to education took about six decades to materialize as a piece of legislation, giving rise to a series of social and political conflicts still centred around questions of access and denial. That of course is a different history.

Conclusion

We have tried to narrate the story, from available evidence, of the indigenous traditions of engagement with the learning of mathematics. In telling the story we have pointed out the strong functionality that resides at the core of curricular and pedagogical practice, and the social basis for it. The story of the colonial encounter could actually be reconstructed as a history of transition of the indigenous elementary institutions into the modern ones, the existing institutions of learning were not only vast in number but had a sustained, resilient presence through the colonial era. The encounter highlights the inherent contradictions of the colonial project. The resilience of indigenous institutions was based on a social resource, namely the public perception of what a relevant curriculum should be in the local school. Training in arithmetic was considered essential for participation in local economic transactions. Set against this was the colonial empire building exercise with its agenda of homogenization, which set out to counter and liberate the pathshala curriculum from its functional ethos, but the pathshala functionality refused to yield. What this left behind was a legacy of mechanical memory as the dominant mode of learning arithmetic, whereas *arithmetic* was not a goal of the *pathshala* but computational ability in context.

The notion of numeracy as defining the modern condition almost synonymous with the idea of literacy also tended to project one particular idea of what it means for a people to learn the world of numbers. Fifty years later, social movements that set out to 'make people literate' discovered remnants of the indigenous pathshala tradition inside the people who were anyway actively engaged with the world of mathematics in diverse ways. Social practices continued to enrich this tradition and helped it survive in many forms (Rampal, Ramanujam & Saraswati, 1999).

Such a historical study raises several questions for the modern social enterprise of universal mathematics education. Can the rich diversity of social and cultural practices be accessed for the purposes of mathematics teaching / learning in school? Does the fact that in this realm the practice of mathematics is embedded in functional terms raise a conflict with the modern articulation of goals of mathematics education, or can these be harmonized? How does a democratic practice of mathematics education address local but public perception of what a relevant mathematics curriculum should be?

While the answers to these and other similar questions are unclear, it must be acknowledged that the diversity of people's ways of engagement with mathematics still remains largely inaccessible to children in school. At the least, mathematics education systems will have to begin by recognizing this fundamental fact from history.

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