must be specially well fitted for one kind of work, and for no other as well.

That would seem to settle the question, but it does so only apparently. The child is a "soft and yielding being." Plant-like, he accommodates himself to influences which play upon him. His aptitudes grow exuberantly on the one side, and become crippled on the other, as friendly or hostile influences prevail. A symmetrically shaped plant will become twisted and distorted if placed against a wall. It depends upon the treatment of the gardener, whether a tree will spend its energy in producing leaves or fruit. A boy six years old may have a talent for art, his sense of form and color may be very pronounced; yet after five years he may be found to have apparently lost that faculty, and developed in a direction which makes the observer prophesy that the boy will become a great lawyer. And, again, after some years he may be found to have developed great skill in manual occupation, having apparently pressed into the background his liking of art and literature.

These are no hypothetical cases. Every observant educator will have come to the conclusion ere this, that it is utterly unfruitful and perilous to fore-ordain a pupil's future. This being the case, it seems to me wise to follow the advice of eminent men; to wit, develop harmoniously all the talents that manifest themselves in the child, and leave the choice of occupation or calling to the developed and ripe judgment of the youth. Do not make this choice irrevocable. Give every one the greatest possible freedom for changing his profession, or occupation, or calling (or give it whatever name you will), if he comes to the conclusion that he missed it in his first choice. A human being who has had the chance and manifold opportunities for testing his natural gifts, and is permitted to exert himself in many directions, will certainly find his natural calling, and achieve great success. Let there be no arbitrary rules, no guild regulations, but let us maintain that liberty of action which has made this nation what it is, the greatest, noblest, most talented, most energetic, most successful, and therefore happiest, nation on the face of the earth.

## HINDU ARITHMETIC.

EUROPEANS who have resided in India have frequently expressed astonishment at the rapidity with which arithmetical calculations are mentally made by very small Indian boys. Some account, therefore, of the Indian method of teaching arithmetic, which is believed to be superior to the English methods, is given by Frederic Pincott, M.R.A.S., in the April number of *Knowledge*, and will probably be interesting to our readers.

The arithmetical system of Europe was revolutionized by India when the so-called Arabic figures which we daily use were borrowed by Arab traders to the Malabar coast, and by them introduced into Europe. It was Indian intelligence which devised the method of changing the values of the numeral symbols according to their positions. This ingenious conception rapidly superseded the older methods, and gave enormously increased facility to arithmetical computations as compared with the Greek and Roman and the older Arabic methods.

In order to explain the present Indian system of arithmetic, it is necessary to premise that the *Pândhes*, or schoolmasters, employ a number of terms unknown to English teachers. These terms have been invented for the purpose of facilitating calculation, and the astonishing results achieved cannot be understood without comprehending the terms employed. The strangeness of the names of the figures and fractions arrests the attention of every student of Hindî. Few attempt to master the fractions; and there are some who, after many years' residence in India, cannot repeat even the numbers from one to a hundred.

Indians use monosyllables similar to ours, from 1 to 10; but from that point the words are built on the model of "1 and 10," "2 and 10," "3 and 10," etc.,[1] up to "8 and 10;" but the word for 19 means "minus 20." After 20 the same method is continued; "21" being impossible, the form is invariably "1 and 20," "2 and 20," up to "minus 30," "30," "1 and 30," and so on. This method of nomenclature goes back to remote antiquity, for the old Sanscrit language presents the same peculiarity.[1] The object of this nomenclature is to facilitate computation; for, in reckoning, the mind has to deal with the even tens, the simplest of all figures to multiply. Thus the question, "9 times 19," is not a simple one to an English child; but the Indian boy would be asked, "9 minus-twenties." In an instant he knows that he has only to deduct 9 minus quantities from 9 twenties, and the answer 171 comes before the English boy has fully realized the question. The formidable difficulty of the 9 is thus completely got rid of by a mere improvement in nomenclature.

Another advantage that the Indian boy has is the use of short, mostly monosyllabic, terms for every ascent in the decimal scale; thus such lumbering expressions as "one hundred thousand" are unknown to him, the simple word *lâkh* conveying the idea fully to his mind. So, also, "one thousand millions" is *arb;* "one hundred thousand millions" is *kharb;* and so on. The advantages of this terseness must be at once apparent.

It is, however, with respect to fractional numbers that the advantage of the Indian system of nomenclature becomes most conspicuous, when once understood. They employ a large number of terms, which are given below.[2]

These terms are *prefixed* when used in combination with whole numbers, the object being to present the special modification to the mind before the number itself is named. Complicated as this nomenclature appears at first sight, its difficulties disappear when brought to the test of practice. It is the outcome of centuries of practical experience, and the thoughtful application of means to an end. It will be sufficient to illustrate the use of these words, and the extraordinary arithmetical facilities they afford, if the use of *paune* is explained, that is, $\frac{3}{4}$, that being the fraction which the English child has most trouble with. The Indian boy knows no such expression as "two and three-quarters;" in fact, the term "three-quarters" in combination with whole numbers has no existence in his language. His teacher resorts to the same device as has been explained when speaking of the figure 9: he employs a term which implies "minus." By this process $2\frac{3}{4}$ becomes *paune tîn*, that is, "minus 3," or "a quarter less 3;" and in the same way $3\frac{3}{4}$ is *paune châr*, that is, "minus 4;" and so on.

Precisely the same plan is adopted with reference to the term *sawâ*, which implies "one-quarter more:" thus $3\frac{1}{4}$ is *sawâ tin* = "plus 3;" $4\frac{1}{4}$ is *sawâ châr* = "plus 4;" etc. It will now be seen that the *whole* numbers form centres of triplets, having a minus modification on one side, and a plus modification on the other. This peculiar nomenclature will be clearly apprehended by the following arrangement: —

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2¾ | paune-tin | —3 | 3¾ | paune-châr | —4 | 4¾ | paune-pânch | —5 |
| 3 | tin | 3 | 4 | châr | 4 | 5 | pânch | 5 |
| 3¼ | sawâ-tin | +3 | 4¼ | sawâ-châr | +4 | 5¼ | sawâ-pânch | +5 |

In multiplying these fractions, therefore, the Indian boy has to deal with only the minus and plus quantities. A simple instance will illustrate this. "7 times $99\frac{3}{4}$" would be a puzzle to an English child, both on account of its lumbering phraseology, and the defective arithmetical process he is taught to employ. The Indian boy would be asked, "*Sât paune-sau?*"—three words meaning "seven minus-hundreds?" The very form of the question tells him that he has only to deduct 7 quarters from 700, and he instantly answers $698\frac{1}{4}$. Equal facility is found with any similar question, such as "5 times $14\frac{3}{4}$?" The Indian boy is asked, "Pânch paune-pandrah?" i.e., "5 minus-fifteens?" As the words are uttered, he knows that he has only to deduct 5 quarters from 5 fifteens; and he answers at once, "Paune chau-hattrah," i.e., "a quarter less four and-seventy" ($73\frac{3}{4}$).

So much for the machinery with which the Indian boy works. The more it is understood, the more it will be appreciated. It is undoubtedly strange to our preconceptions; but it would be a

[1] This is also the original meaning of the English words "eleven," "twelve," etc., up to "nineteen."

[1] In the ancient language there was also an optional form in conformity with the English method.

[2] Pâ,o = ¼; âdh = ½; paun = ¾; paune = —¼ (¼ less than any number to which it is prefixed); sawâ = 1¼ (¼ more than any number to which it is prefixed); sârhe = + ½ (½ more than any number to which it is prefixed); derh = 1½ (a number + half itself); pawannâ = 1¾; arhâ,î = 2½ (twice and a half times any number); hûnthâ = 3½; dhaunchâ = 4½; pahûnchâ = 5½.

real blessing to our country if corresponding suitable terms were invented, and this admirable system were introduced into all our schools.

Some Europeans have sought to account for the surprising results attained by Indian children, by attributing them to special mental development due to ages of oral construction. It is perfectly true that Indians rely more on their memories than on artificial reminders, and no one can come into contact with the people without being struck by their capacity for remembering. It is well known that many of the ablest men the country has produced could neither read nor write ; but they hardly missed those accomplishments, for their minds were frequently stored with more information, which was more ready to their command, than that possessed by the majority of book-students. It is well known that Ranjît Singh could neither read nor write, but he knew all that was going on in every part of a kingdom as large as France. He was an able financier, and knew at all times accurately the contents of all his treasuries, the capacities of his large and varied provinces, the natures of all tenures, the relative power of his neighbors, the strength and weakness of the English, and was in all respects a first-class administrator. We commit the mistake of thinking that the means to knowledge is knowledge itself. This induces us to give all the honor and prizes to reading and writing, and leads us to despise people, whatever their real attainments may be, who have not acquired the knack of putting their information on paper. It ought to modify our opinion on this point to reflect that the architectural triumphs of India were nearly all built by men who could neither read nor write. Another illustration of dependence upon memory instead of paper can be found in the Indian druggist, who will have hundreds of jars, one above another, from floor to ceiling, not one of them marked by label or ticket, yet he never hesitates in placing his hand on the right vessel whenever a drug is required. The same, to us, phenomenal power of memory is shown by the ordinary washermen, who go round to houses with their donkeys, and collect the clothes, some from one house, some from another. These they convey to the river and wash, and, in returning with the huge pile, never fail to deliver each particular article to its rightful owner.

The Indian boy's first task is necessarily to commit to memory the names of the figures from 1 to 100. He is next taught that there are nineteen places for figures, and their names. These correspond to our units, tens, hundreds, etc.; but the monosyllabic curtness in the names of the higher numbers is his distinct advantage.

What we call the multiplication table then begins. In England the multiplier remains constant, and the multiplicand changes: thus children repeat, "twice one, two; twice two, four; twice three, six;" etc. In India the boy is taught to say, "one two, two; two twos, four; three twos, six;" etc.; his multiplier changing, while the multiplicand remains fixed. Another peculiarity is this: he begins at 1, not at 2; and this furnishes him with a series of most useful collective numbers. Here, again, the English language lacks terms to translate the first table, but an idea may be gained from the following attempt: one unity, one; one couplet, two; one triplet, three; one quadrat, four; one pentad, five; etc.

These names for aggregates, as distinguished from mere numerals, are of much value to the boy in the subsequent processes, and give him another distinct advantage.

In learning these tables the boy is not carried beyond 10; that is, he goes no further than "two tens, twenty," "three tens, thirty," etc.; but to make up for that forbearance he is carried on in this process of multiplying figure by figure not only to 12, or up to 20, but he goes on through the thirties, and does not make his first halt until he gets to "ten forties, four hundred." In achieving this result something more than mere memory is brought into play, for he is taught to assist his memory by reference from one table to another; thus the first half of the six table is contained in the three table, etc.

A short supplementary table is next taught, beginning at $11 \times 11$ to $20 \times 11$, and then proceeding to $11 \times 12$ to $20 \times 12$, and so on up to $20 \times 20$. This method reduces considerably the tax on the memory; for one-half of the table is obviously the same as the other half, and therefore only half calls for special effort.

The boy has now committed to memory the multiplication of every figure from $1 \times 1$ to $20 \times 20$, and in addition he knows the multiplication of every figure up to 40 by the ten "digits." It will be observed that both tables end at 400 ($10 \times 40$ and $20 \times 20$); in fact, 4 is the most important factor in Hindu arithmetic, all figures and fractions being built upon multiples and fractions of it.

At this point, instead of practising on imaginary sums in the hope of learning arithmetic empirically, the Indian lad immediately proceeds to tables of fractions, the first being the multiplication of every figure from 1 to 100 by $\frac{3}{4}$. Here, again, $\frac{3}{4}$ would be the last fraction we should attempt; but in India it is the first, and, by the superior system of nomenclature there in use, it is a very easy affair. The boy, knowing the multiplication of the whole numbers, is taught to deduct the half of the half ($\frac{1}{4}$), and the thing is done. Memory is assisted by observing that every multiple of 4 is a whole number, and that the number below it will always be a *sawâ* of the next lower figure, and the number above it always a *paune* of the next higher figure. Thus in answer to the question $\frac{3}{4} \times 36$, the Indian boy says mentally, 18, 9, 27; he also knows that 36 is the ninth multiple of 4, and by immediately deducting 9 can get his 27 that way also. Knowing, also, that 36 is a multiple of a 4 yielding 27, he knows that 35 will yield *sawâ chhabbîs* ($26\frac{1}{4}$), and that 37 will yield *paune athâ,îs* ($-28=27\frac{3}{4}$). In this way three-fourths of the table is a matter of logical necessity, resting on the elementary table previously acquired.

In the next table the boy is taught to multiply every figure from 1 to 100 by $1\frac{1}{4}$. This, of course, is precisely the reverse of the last: the $\frac{1}{4}$ is ascertained and added, instead of being deducted. Here, again, the multiples of 4 are whole numbers; but the figures preceding result this time in a *paune*, and those next following in a *sawâ*. This table also costs but little effort when thus taught.

The next table teaches the boy to multiply from 1 to 100 by $1\frac{1}{2}$, and of course means simply adding half the multiplier to the figure itself.

The next step, multiplying from 1 to 100 by $1\frac{3}{4}$, is achieved by simply adding three-quarters of the multiplier to the multiplier itself. The "three-quarters" table has been already acquired by the boy, and he has therefore only to add any given multiplier to it. Thus, if asked, "What is 27 times $1\frac{3}{4}$?" he knows that 27 *paunes* are $20\frac{1}{4}$: he has therefore only to add this to the 27 itself to get $47\frac{1}{4}$ as the instant answer.

The boy is next exercised in multiplying 1 to 100 by $2\frac{1}{2}$, and he is taught to do this by adding half the multiplier to the "twice-times" table.

Then follow similar tables multiplying by $3\frac{1}{2}$, $4\frac{1}{2}$, and $5\frac{1}{2}$; and the results are arrived at instantaneously by adding to the "three-times," "four-times," and "five-times" tables half the multiplier in every case.

In all these tables the rapidity and simplicity is in great part due to the terms employed. The boy is not asked to "multiply seventeen by three and a half," or "What is three and a half times seventeen?" or puzzled by any other form of clumsy verbosity. The terms he uses allow him to be asked "*sattrah hûnthe*" ("seventeen three-and-a-halfs"). His elementary table has taught him that $17 \times 3 = 51$, and he knows that he has only to add half 17 to that, and the sum is done.

The final task of the Indian boy is a money table, which deals with a coinage which may be thus summarized: 16 *damrî* = 1 *takâ;* 16 *take* = 1 *ânâ;* 16 *âne* = 1 *rûpî.*

There is a small coin called *dâm*, three of which make 1 *damrî;* and therefore 48 make 1 *takâ*, and 96 = *ânâ*, $4^2$ being still the unit. The table imparts a familiarity in combining these coins together.

This completes an Indian boy's most elementary course of arithmetic; and a little reflection on the great facility for computation which Indian children show, and the simplicity of the means by which it is effected, ought to make us rather ashamed than boastful of our own defective methods.