<u>Draft seminar proposal</u>

Indian ganita and Western ethnomathematics

The term "ethnomathematics" was coined by Ubiratan D'Ambrosio[1] for various indigenous practices of mathematics which may have a different, though equally sound, epistemic basis. However, today the term is used so as to exclude "mainstream" mathematics, or formal mathematics, more properly called Western ethnomathematics, globalised by colonialism. Western ethnomathematics is effectively regarded as "superior" and "universal" in contrast to all other traditions which are deemed local (and inferior), much as whites were deemed superior to non-whites for centuries in the West. There is also a widespread belief that Western ethnomathematics is the only mathematics that can be used for science and technology. These beliefs are reflected in the present-day math classroom, which exclusively teaches Western ethnomathematics, but the beliefs have been subjected to little scrutiny by critically examining them from both a philosophical and historical perspective.

India has a special stake in such a critical re-examination, because the epistemology of Indian ganita differs from that of Western ethnomathematics normatively deemed universal. Historically speaking, most present-day school mathematics—arithmetic, algebra, trigonometry and calculus,[2] probability and statistics[3]—went to the West from India for its practical value. For example, efficient Indian arithmetic (in contrast to crude Roman arithmetic) was repeatedly imported by Europeans, first by Gerbert in the 10th c., via Cordoba and Baghdad, then by the Florentine merchants (such as Fibonacci) in the 13th c., from Muslim traders in Africa, for its practical value in commerce, and finally by Christoph Clavius directly from Cochin, in the 16th c. However, the West had great difficulties in comprehending the different epistemology of Indian ganita, even in the case of elementary arithmetic "algorithms". Gerbert (later Pope Sylvester II) got an abacus built for "Arabic numerals", for he thought the inefficient abacus was the only way to do arithmetic! Florence passed a law against the "mysterious" zero (from sifr, cipher), requiring all financial contracts (in "Arabic numerals") to be written also in words, since native Europeans were accustomed only to numerals which are additive like Roman numerals. For the Gregorian reform of the calendar, Clavius still used a confusing system of leap years, not straightforward fractions, to represent the altered duration of the tropical year (which inferior method gets the tropical year right only on a thousand-year average, not from year to year). The Western epistemic problems with trigonometry, calculus, and probability were far more severe, but are less known because of major falsehoods in the Western "mainstream" history of mathematics, and tight Western control of "acceptable" philosophy.

Ironically, during colonialism, Indian ganita draped in Western epistemological garb, and packaged with a Western chauvinist history, was returned to India (and globalised) as part of colonial education. It is only in the last two decades, that serious questions have been raised challenging the supposed superiority of Western ethnomathematics or formal mathematics, the veracity of its purported historical origins,[4] and the possibility of an alternative decolonised mathematics curriculum, using a different philosophy of mathematics.[5]

For example, a formal mathematical proof must begin with axioms, not facts, and no facts or empirical observations are allowed to be introduced in the course of such a proof.[6] This formal reasoning differs from normal or scientific reasoning in prohibiting the use of facts. Contrary to widespread Western myths, Greeks never used formal reasoning: not a single theorem in "Euclid's" Elements, is proved formally, a fact admitted in the West only at the turn of the 20th c. Such was nevertheless still deemed to be "Euclid's" intention on the "Euclid" myth.[7]

Though not found in Greek tradition, such a method of formal reasoning (without facts) greatly suited the Western church after it adopted a new theology based on reason during the Crusades. For example, Aquinas[8] reasoned about the number of angels that can fit on the head of a pin, axiomatically laying down that angels occupy no space. This church method of using authoritatively stipulated axioms to bypass the physical world, and do extensive metaphysics, especially a particular metaphysics of infinity, is at the heart of formal mathematics. For example, the axiom that there is a unique straight line through two geometric points, does not hold anywhere in the physical world. This metaphysics adds nothing to the practical value of normal mathematics (ganita) which all relates to the physical world, and accepts empirical proofs. The philosophical claim about the infallibility of deduction is easily shown to be just another a church myth: in fact deductive proofs are more fallible than empirical or inductive proofs, and formal mathematical theorems may not even be approximately valid knowledge.[9] Indeed, since science is based on mathematics, the metaphysics in formal math may creep into authoritatively accepted science to the detriment of real science.[10]

However, the responses of top Western scholars to such critiques have been disappointing, and much like the traditional church techniques of suppressing dissent. Apart from decades of silence, followed by censorship,[11] the response of Western scholars has been mostly to attack the persons advancing the arguments, and a complete failure to engage with the substance. Obviously, this only tends to corroborate that the critique does not admit of any easy response, and Western scholars are well aware of it.

This is a major encouragement to further explore the decolonised math curricula that have been proposed over the last decade, as in actual university courses on calculus without limits,[12] and school-level courses on rajju ganita.[13] A very attractive feature of these decolonised curricula is that they make math easy, by stripping off the redundant and complex metaphysics that Western ethnomathematics requires at every level, starting from 1+1=2, and which makes math difficult today. Consequently, this enables students to solve harder practical problems related to science and technology.

1 Ubiratan D'Ambrosio,. "Ethnomathematics and its place in the history and pedagogy of mathematics." *For the Learning of Mathematics*, **5**(1), 1985, pp. 44–48. *JSTOR*, www.jstor.org/stable/40247876.

2 C. K. Raju, *Cultural Foundations of Mathematics: the nature of mathematical proof and the transmission of calculus from India to Europe in the 16th c. CE*, Pearson Longman, 2007.

3 C. K. Raju, "Probability in Ancient India", *Handbook of the Philosophy of Science*, vol 7, *Philosophy of Statistics*, ed. Prasanta S. Bandyopadhyay and Malcolm R. Forster. General Editors: Dov M. Gabbay, Paul Thagard and John Woods. Elsevier, 2011, pp. 1175–1196.

4 C. K. Raju, "Computers, Mathematics Education, and the Alternative Epistemology of the Calculus in the YuktiBhāsā", *Philosophy East and West*, **51**(3) (2001) pp. 325–362.

5 C. K. Raju, "Teaching Mathematics with a Different Philosophy. 1: Formal mathematics as biased metaphysics". *Science and Culture* **77** (2011) 275–80. arXiv:1312.2099.

6 E.g., E. Mendelson, Introduction to mathematical logic, van Nostrand, New York, 1964, p. 29.

7 C. K. Raju, *Euclid and Jesus: How and why the church changed mathematics and Christianity across two religious wars*, Multiversity, Penang, 2012.

8 Thomas Aquinas, *Summa Theologica*, First Part, Q. 52, article 3. http://www.newadvent.org/summa/1052.htm#article3.

9 C. K. Raju, "Decolonising mathematics", Alter*Nation* **25** (2) (2018) pp. 12-43b, https://doi.org/10.29086/2519-5476/2018/v25n2a2,

10 C. K. Raju, *The Eleven Pictures of Time: the physics, philosophy, and politics of time beliefs*, Sage, 2003.

11 C. K. Raju, "To decolonise math stand up to its false history and bad philosophy", (CENSORED article) *Conversation* 24 Oct 2016, on http://ckraju.net/blog/?p=117, retained in the Wire post-censorship, https://thewire.in/history/to-decolonise-maths-stand-up-to-its-false-history. Reproduced in full in "Black thoughts matter", *Journal of Black Studies*, **48**(3) (2017) pp. 256–278. https://doi.org/10.1177/0021934716688311. Also in *Rhodes Must Fall* (Oxford), Zed books, 2018, chapter 26. Some further details in "Mathematics and censorship", https://kafila.online/2017/06/25/mathematics-and-censorship-c-k-raju/.

12 C. K. Raju, "Teaching Mathematics with a Different Philosophy. 2: Calculus without limits". *Science and Culture*, **77** (2011) 281–86. arXiv:1312.2100.

13 C. K. Raju, *Rajju ganita: an alternative math text on string geometry for class IX*, Multiversity, Penang, 2019.