

Ganita vs formal mathematics: re-examining mathematics, its pedagogy, and the implications for science

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Extended abstract

People believe math is universal, but colonial education changed the math we teach. Our current class 9 NCERT text teaches that the “Greeks” alone did a “superior” kind of math, involving “reason”, which math we should all imitate. Setting aside the total lack of historicity, people assume that “reason” means normal reason (reason plus facts), as in Aryabhata’s deduction that the earth is round since far off objects cannot be seen. However, in the school text it means *formal* reason (reason MINUS facts), as in the church theology of reason. All Indian notions of proof (including in *ganita*) accept *pratyaksa pramana*, or the empirically manifest, as the first means of proof, and most accept also inference, as did normal mathematics worldwide. However, a formal mathematical proof¹ prohibits the use of the empirical.² While everyone accepts that empirical proofs are fallible, it is a uniquely Western superstition that pure deductive proofs (without facts) are infallible. The claim of universality of math is, thus, normative, and pushes us to accept this globalised superstition as a norm.

The West has always connected mathematics to *religious* beliefs since Plato, as the very name “mathematics” shows. [Hence, it superstitiously believes mathematics is “exact”, since “eternal” truth (which arouses the eternal soul by sympathetic magic).]³ The church cursed that notion of soul⁴ and closed all schools of mathematics in 532 CE. However, during the Crusades, the church adopted the (Christian) theology of reason (from the Islamic theology of reason, with a view to convert Muslims). It found facts inconvenient for they frequently contradict church dogmas. Hence, it glorified reasoning MINUS facts (formal reasoning), and reliance instead on authoritative assumptions (axioms, postulates), about UNREAL entities such as angels or invisible geometric points (NCERT, class 6). The church used “Euclid's” *Elements* as a text to teach its priests to reason in this tricky metaphysical way, until the 20th c. when it was finally admitted that the book (though it has axioms) does not have a single axiomatic or formal deductive proof, as ALL Western scholars wrongly believed for centuries! Ironically, 20th c. formal math is founded on the superstition that deductive proofs are infallible. The slightest commonsense shows that deductive proofs are MORE fallible than inductive proofs. For detailed arguments about the fallibility of deduction, see my recent article on “Decolonising math”.⁵

While formal math does not add ANYTHING to the practical value of math (for science and engineering, from rockets to artificial intelligence, which practical value all comes from normal math) it adds greatly to the DIFFICULTY of math: e.g. most people (including most professional mathematicians) would be unable to prove even $1+1=2$ (in “real” numbers) from first principles (without assuming even set theory). Try it! :)

Historically speaking, the West was backward in mathematics (even elementary arithmetic) from Greek and Roman times.⁶ Hence, most school mathematics today (arithmetic, algebra, “trigonometry” and calculus,⁷ probability and statistics⁸) was imported by Europe, from India, for its practical value, between the 10th and 16th c. CE. However, because of epistemic differences, the West had severe difficulties for centuries in understanding even elementary Indian arithmetic, “trigonometry” etc. The West totally failed to understand the epistemic basis of the Indian calculus and its infinite series, badly needed to solve the (specifically) European navigational problem, on which European dreams of overseas wealth rested. Eventually (by the 1930’s), the West invented a huge metaphysics of infinity (formal “real” numbers, axiomatic set theory), aligned to church dogmas of eternity.⁹ To reiterate, this metaphysics added zilch to the practical value of the Indian calculus (e.g. for physics), but made it difficult for most students to understand calculus. (See stock pre-test,¹⁰ on which no

engineering undergrad student so far high-scored even zero!) Colonial education returned our own mathematics to us mixed with Western metaphysics, and declared it superior. This infusion of metaphysics does add to the POLITICAL value of formal math, for it allows church dogmas (e.g. about creation) to creep into science, as in the work of Stephen Hawking.¹¹ But that political value is only for the coloniser, not the colonised.

Colonialism was not a mere physical conquest: it involved capture of the mind through colonial education. Colonial education came ostensibly for science. However, paradoxically, the fact is that the mass of the colonially “educated”, today, are (a) ignorant of basic mathematics, essential for science, but are (b) systematically stuffed with a mass of false myths, even about math and science resulting in various prejudices and superstitions. This was no accident; ignorance, false myths, superstitions etc. are stock tools of church power, though the colonised never noticed that Western education (including university education, from “prestigious” Oxford, Cambridge, Paris...) was a 100% church monopoly, when it first came to the colonised.

Though colonial education teaches blind imitation of the West (e.g. unscientific calendar), decolonisation (or emancipation of the colonised mind) requires a *critical* re-examination of colonial education.¹² However, for the colonised, a serious (non-Western) critique of the master is taboo, and colonial “education” alienates them from their own traditions. Any attempted critique is censored worldwide,¹³ following the stock church method of preserving lies. Further, Western scholars, too, only lie and personally abuse the critic, using another time-honoured church method of propaganda. To reiterate, unlike Tagore, I accept any (demonstrated) utilitarian value of colonial education, but seek to decolonise by identifying and eliminating its propagandist aspects.

The present project involves three aspects. First, it is important to compare the philosophy of ganita (normal math) with formal math, for we rejected ganita without a critical comparison. I would compile and update the comparison done over the past two decades, including challenges to myths of “Euclid” and “Pythagoras”. Second, I would also compile and update scattered reports of the pedagogical experiments on teaching an alternative (normal) mathematics (not the same as teaching math in an alternative way!). This alternative (normal) math includes teaching calculus without limits in five days [using Aryabhata’s numerical method to solve ordinary differential equations, Brahmagupta’s avyakt ganita (non-Archimedean arithmetic), and zeroism,¹⁴ to sum infinite series]. These teaching experiments¹⁵ were conducted in 3 countries, in 6 universities with 10 groups, and demonstrated that (undergraduate) students acquire clear calculus concepts and can solve much harder problems omitted in usual university calculus courses across the world.¹⁶ The project would also document similar pedagogical experiments with rajju ganit (string geometry) a text book on which is ready at the level of class 9, and how this results in clear geometrical concepts, instead of the nonsense hotch-potch which is currently taught.¹⁷ (Happy to demonstrate by asking the audience questions.)

Third, the project would also explore the implications of decolonised math for a better science. Thus, Newtonian physics failed just because Newton failed to understand the imported Indian calculus and hence made time metaphysical. The resulting *conceptual* correction to Newtonian physics (special relativity) was improperly understood (it requires functional differential equations).¹⁸ Accordingly, Newtonian gravitation should have been first made compatible with special relativity as in my retarded gravitation theory (RGT).¹⁹ I would check if RGT can be tested using replicable experiments. Another aspect concerns the use of *avyakt ganit* (“non-Archimedean” arithmetic) to avoid the problems with the university calculus which problems necessitated the Schwartz theory of distributions, and *its* problems with products etc.,²⁰ and the related empirically testable consequences (e.g. shock waves) as appropriate.

- 1 For the stock definition of a formal mathematical proof see, e.g., the text by E. Mendelson, *Introduction to mathematical logic*, van Nostrand, New York, 1964, p. 29.
- 2 For an early comparative discussion of the prohibition of the empirical in formal math see e.g. 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.
- 3 CKR, “Teaching mathematics with a different philosophy. 1: Formal mathematics as biased metaphysics.” *Science and Culture* **77** (2011) pp. 275–80. arXiv:1312.2099.
- 4 “The curse on ‘cyclic’ time”, chp. 2, in the CKR, *The Eleven Pictures of Time*, Sage, 2003.
- 5 CKR, “Decolonising mathematics”, *AlterNation* **25**(2) pp. 12-43b.
DOI:<https://doi.org/10.29086/2519-5476/2018/v25n2a2>. Alternative download from “Decolonising mathematics: discarding church myths and superstitions”, <http://ckraju.net/blog/?p=179>.
- 6 The simple non-textual proof is that Greek (Attic) and Roman numerals result in excessively inefficient arithmetic, and the Greek and Roman calendar were defective because neither knew (precise) fractions, hence neither could easily articulate the duration of the tropical years. Hence the system of leap years used even in the 16th c. Gregorian reform.
- 7 CKR, *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. Quick summaries in articles in: *Encyclopedia of Non-Western Science, Technology and Medicine*, (ed. Heiline Selin) Springer, 2014, 2016. “Calculus” pp. 1010–1015, <http://ckraju.net/papers/Springer/ckr-Springer-encyclopedia-calculus-1-final.pdf>, “Calculus transmission”, pp. 1016–1022. <http://ckraju.net/papers/Springer/ckr-Springer-encyclopedia-calculus-2-final.pdf>
- 8 CKR, “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. <http://ckraju.net/papers/Probability-in-Ancient-India.pdf>.
- 9 CKR, “Eternity and Infinity: the Western misunderstanding of Indian mathematics and its consequences for science today.” *American Philosophical Association Newsletter on Asian and Asian American Philosophers and Philosophies* **14**(2) (2015) pp. 27–33. <http://ckraju.net/papers/Eternity-and-infinity-Pages-from-APA.pdf>.
- 10 <http://ckraju.net/sgt/3-question-paper-pre-test-ugt.pdf>. (Pre-test conducted at SGT University, Delhi, 2017.)
- 11 CKR, *The Eleven Pictures of Time*, Sage, 2003. For a popular account, see, “The Christian propaganda in Hawking’s work”. *Daily News and Analysis*, full page article, 16 Jan 2011, <https://www.dnaindia.com/lifestyle/review-the-christian-propaganda-in-stephen-hawking-s-work-1495047>, or archived version at “Hawking singularities”, <http://ckraju.net/blog/?p=50>.
- 12 CKR, “Be critical, choose what is best”, public statement in *The Sun*, Malaysia, 29 Aug 2011, p. 16. Archived at <http://ckraju.net/press/2011/the-Sun-29-Aug-2011-p16-clipping-ckr-response.gif>. The public debate starting with an editorial in the *Sun* on my talk is archived at “Decolonisation: conversations in the Sun”, <http://ckraju.net/blog/?p=61>.
- 13 E.g. CKR, “To decolonise math, stand up to its false history and bad philosophy”, (<http://ckraju.net/blog/?p=117>) article published by *Conversation* (Global edition) on 24 Oct 2016, went viral, then CENSORED, by its South Africa editor on the strange ground that non-Whites are not editorially allowed to cite their own published research. The article was reproduced worldwide, and then censored, e.g. in India by both Scroll and Wire. But the Wire put it back (<https://thewire.in/history/to-decolonise-maths-stand-up-to-its-false-history>). The censored article was reproduced in full in “Black thoughts matter...”, *J. Black Studies*, **48**(3) (2017) pp. 256-278. Also in *Rhodes Must Fall* (Oxford), Zed Books, London, 2018, chp. 26. See, also, CKR, “Mathematics and censorship”, Kafila, <https://kafila.online/2017/06/25/mathematics-and-censorship-c-k-raju/>.
- 14 CKR, “Zeroism”, in *Encyclopedia of Non-Western Science, Technology, and Medicine*, Springer, 2016, , pp. 4604–4610. <http://ckraju.net/papers/Springer/zeroism-springer-f.pdf>.
- 15 E.g. CKR, “Teaching Mathematics with a Different Philosophy. 2: Calculus without limits”. *Science and Culture*, **77** (2011) 281–86. arXiv:1312.2100. Or, “Calculus without Limits: Report of an Experiment” 2nd People’s Education Congress, HBCSE, TIFR, Mumbai, Oct 2009. In Proc. <http://ckraju.net/papers/calculus-without-limits-paper-2pce.pdf>
- 16 See a stock first tutorial sheet posted at <http://ckraju.net/sgt/Tutorial-ugt.pdf>.
- 17 See, e.g, the detailed grievance against NCERT: <http://ckraju.net/geometry/NCERT-grievance-detailed-note.pdf>.
- 18 CKR, *Time: Towards a Consistent Theory*, Kluwer Academic, Dordrecht, 1994. Funda. theories in physics, vol. 65.
- 19 CKR, “Retarded gravitation theory” in: Waldyr Rodrigues Jr, Richard Kerner, Gentil O. Pires, and Carlos Pinheiro (ed.), *Sixth International School on Field Theory and Gravitation*, American Institute of Physics, New York, 2012, pp. 260–276. http://ckraju.net/papers/retarded_gravitation_theory-rio.pdf. A more expository paper is “Functional Differential Equations. 4: Retarded gravitation”, *Physics Education* (India) **31**(2) April-June, 2015, [http://www.physexu.in/uploads/publication/19/309/1-Functional-differential-equations-4-Retarded-gravitation-\(2\).pdf](http://www.physexu.in/uploads/publication/19/309/1-Functional-differential-equations-4-Retarded-gravitation-(2).pdf)
- 20 E.g. CKR, “Products and Compositions with the Dirac Delta Function.” *J. Phys. A: Math. Gen.* **15** (1982) pp. 381–96. Also, “Distributional Matter Tensors in Relativity.” In: *Proc. Fifth Marcel Grossman Meeting on General Relativity*, Perth, 1988, ed. D. Blair and M. J. Buckingham , R. Ruffini (series ed.), World Scientific, Singapore, 1989, pp. 421–23.

Short bio

Professor C. K. Raju holds a BSc (Hons) in physics and an MSc math from Mumbai, followed by a PhD from the Indian Statistical Institute, Kolkata. He taught and researched in formal math (functional analysis, Schwartz distributions) and mathematical physics for several years, before joining C-DAC to play a key role in building the first Indian supercomputer Param. He was responsible for porting applications of national importance (space, oil), and that experience led him to abandon formal math.

He has authored several books. In *Cultural Foundations of Mathematics* (Pearson Longman, 2007) he proposed a new philosophy of math, called zeroism, and compiled evidence for the development of calculus in India and its transmission to Europe. This motivated his efforts over the last decade, as part of the Multiversity movement, to develop and teach several decolonised courses including on calculus, geometry, statistics, and also the history and philosophy of science. Earlier, in *Time: Towards a Consistent Theory* (Kluwer Academic, Dordrecht, 1994) he pointed out that existing physics must use functional differential equations, preferably with a tilt in the arrow of time. In the *Eleven Pictures of Time* (Sage, 2003) he proposed a new way to relate science and religion through time. His shorter books include *Is Science Western in Origin?* (Multiversity 2010), *Ending Academic Imperialism* (Citizens International, 2011) and *Euclid and Jesus* (Multiversity, 2012). Some books have been translated into Hindi, Kannada, Farsi, and Spanish.

He has long been a Professor in various departments, including, mathematics, computer science, and also humanities in universities in India and abroad. He was earlier a Fellow at IAS from 1991-93, and on the editorial board of the Journal of Indian Council of Philosophical Research. He is currently an Honorary Professor (Indian Institute of Education), and an Emeritus Professor (SGT University).

He has lectured on six continents, ranging from prominent universities and institutes such as MIT, ICMC Brazil, Cape Town, UNISA, Durban, Auckland, Australian National University, National University of Singapore, USM, IISc, TIFR, Max Planck Institutes, Munich, Berlin, Amsterdam, Lyon, ICTP, Trieste, Tehran, Beirut, to Soweto, and refugee camps in Palestine, and remote village schools in India. Several videos of his lectures and interviews have been very popular.

He has received numerous honours and awards, including the TGA award in Hungary in 2010, for correcting Einstein's mistake, Fellowship of the Institute of Complex Thought, Lima, Bharatiya Dharohar Award, MP Ratna, etc.

He blogs at <http://ckraju.net/blog>.