Ganita vs mathematics

Ten myths underlying formal math and the need to reject them

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Extended abstract

We reject the myth that Western math is universal. That was always a *normative* universality: while it was admitted that other ways of doing math existed, it was claimed that Western math was "superior". This claim of "superiority" (e.g. the claim that metaphysical proofs are "superior" to empirical proofs) rests merely on some anti-scientific church dogmas born of hate politics. Further, the purported "superiority" of Western math, exactly like racist claims of "superiority", is supported by the very same fabricated church/racist/colonial history (e.g. the myth of Euclid *and* the myth of his deductive proofs).

Any serious study of plurality in math must critically re-examine other ways of doing math, and *select* the better way of doing math. *Which* math should be taught in schools and universities? We cannot just assume that existing (colonial) math education should persist. Nor even can we continue to justify it merely on unexamined Western myths and dogmas, even if they are widely believed today (just *because* colonial education propagates them). Indeed, since math is taught as a *compulsory* subject in schools today, if the present way of teaching it rests on (and subtly propagates) religious dogmas, and related myths, as it does, its teaching *must* be changed in schools in any secular country.

To this end, of deciding *which* math is better, we compare formal math with religiously-neutral Indian *ganita* (together with the explicit philosophy of zeroism). We have selected *ganita* not for reasons of its Indian origins, but because it concerns practical value, which is surely more universal than Western dogmatic metaphysics. Further, most math taught in schools today (arithmetic, algebra, trigonometry, calculus, probability) historically originated as *ganita*. Also, those same *ganita* techniques of calculation continue to be used today for almost all practical applications of math to commerce, science and engineering (and indeed in all computer-based numerical calculations, such as those used to send a spacecraft to Mars, or to make stock-market predictions).

While the West imported *ganita* for its practical value, its epistemology clashed with the religiously-loaded epistemology of math in the West (e.g. all computer-based numerical calculations are today declared "erroneous"). *Ganita* was made theologically correct by (a) giving it a veneer of metaphysics (e.g. the use of metaphysical limits in calculus, to align its notion of infinity with church dogmas about eternity), and (b) packaging it with a false history (e.g. that Newton and Leibniz invented the calculus). This cocktail of practical value, religious metaphysics, and false history, was just declared "superior" and globalised by colonial education. Selecting *ganita* over formal math preserves the practical value, while eliminating the false history and bad metaphysics. Indeed practical value is enhanced: e.g., eliminating Newton's conceptual confusion about calculus leads to a better theory of gravity. Or, e.g., teaching calculus as *ganita* enables students do harder problems.

However, the bad metaphysics and false history, underlying formal math, is a key part of colonial indoctrination ("education"). The indoctrinated cling to myths: when one myth is challenged, they try to "save" it by appealing to another (e.g. if the myth of Euclid is challenged they invoke the myth of deductive proofs in the *Elements*). Hence, to decolonise, the whole collectivity of myths must be simultaneously denied. If this denial is to be intelligible, it cannot also be brief: for brevity assumes shared beliefs. Thus a demand for brevity, in this context, becomes a trick to block dissent.

1. Background

We reject the myth (1) of Euclid (and point to my unclaimed challenge prize for evidence about Euclid). We reject the myth (2) that the *Elements* concerned deductive proof. Though the latter myth is so obviously contrary to facts, *all* Western scholars chose myth over facts, for 8 centuries. How does one explain that remarkable cognitive collapse? Presumably it was not due to generic Western cognitive incompetence, but because of the pressure to believe the myth arising from its linkages to church dogmas. Formal math itself arose as an attempt to save the myth, by rewriting the *Elements* to make it conform to the myth, after the facts were finally admitted, in the 20th c. However, we also reject the current school-text myth (3) that Hilbert's synthetic geometry or Birkhoff's axiomatisation offer a valid[1] reinterpretation of the *Elements*.

The religious roots of formal math run very deep, but it is important to understand them for the existence of those linkages makes formal math unfit to be taught in schools today. The tradition of Egyptian mystery geometry persisted for centuries in the West, from Plato to Proclus; it linked math to mathesis or soul arousal. Early Christianity too shared this notion of soul which was cursed by the post-Nicene church,[2] hence math was banned from the Roman empire in the 6th c.

The *Elements* was accepted back in the 12th c., when the church launched the Crusades to convert Muslims by force. The military failure of the later Crusades led the church to revise its theology. This post-Crusade Christian theology of reason (of Aquinas et al.) copied extensively from the Islamic theology of reason (*aql-i-kalam*), with its well-known linkages to "Neoplatonism". This copying aimed to convert Muslims using methods of arguments *they* accepted. To this end, the church also "reinterpreted" the "Neoplatonic" *Elements,* to align it with the new theology of reason: it was claimed that geometry concerned not the soul but solely reasoning (or persuasion). Attributing the origins of "real" geometry to an unknown early Greek called Euclid was not only the stock church method of falsifying history, it helped to impose this theologically-correct reinterpretation through just one forged remark about the purported intentions of the fictitious Euclid. All this is elaborated in *Euclid and Jesus*.[3]

We reject the myth (4) that deductive proofs are "superior" to empirical proofs. This myth too is linked to dogma. Al Ghazali had casually conceded the Egyptian/"Neoplatonic" belief in "divine reason", and allowed that logic bound Allah, for his immediate concern was cause, not reason. Aquinas, who studied al Ghazali, elevated this to a universal principle: logic bound God, so God could not create an illogical world, but was free to create the facts of his choice.[4] Hence logical proofs were declared superior to empirical proofs on the dogma that logic was "superior" to God who was "superior" to facts. This dogma is NOT universal: the Lokayata (who do not believe in any God) rejected inference (*anumana*) as inferior and *more* fallible compared to the *pratyksa* (or empirically manifest).

The infallibility of deductive proofs is a myth, if only because there is no certain way for humans to be sure whether a deductive proof is valid. The most ironic example that of the elementary proof of the first proposition of the *Elements* which was wrongly accepted as a valid deductive proof by all Western scholars for centuries. (The validity of complex computer-generated proofs, such as that of the four-color theorem, is much harder to decide.) There are more fundamental issues: *all* Indian schools of

1 C. K. Raju, *Cultural Foundations of Mathematics: the nature of mathematical proof and the transmission of the calculus from India to Europe in the 16th c. CE*. Pearson Longman, 2007. Chp. 1, "Euclid and Hilbert".

2 C. K. Raju, *The Eleven Pictures of Time: the physics, philosophy, and politics of time beliefs*, Sage, 2003. Chp. 2, "The curse on 'cyclic' time".

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

4 C. K. Raju, "The Religious Roots of Mathematics", *Theory, Culture & Society* **23**(1–2) Jan-March 2006, pp. 95–97.

philosophy accept *pratyaksa* (or the empirically manifest) as a valid means of proof, as does Islam (*tajurba*) or science (experiment). So, rejecting empirical proofs as "inferior" also rejects *all* Indian philosophical systems, at one stroke, and propagates a bias in favour of anti-scientific church dogmas.

We also point out the falsehood of the myth (5) that logic is universal (and the myth (5') that Aristotle of Stagira invented the syllogism which myth again comes from 12th c. Toledo translations[5]). Logic is NOT culturally universal: in India, various logics prevailed since pre-Buddhist times, and persist in the Buddhist *catuskoti*, or Jain *syadavada* (perhaps-ism). Hence, imposing 2-valued logic on *cultural grounds* is unacceptable. On the other hand, if 2-valued logic is asserted to be the case on *empirical grounds*, then the myth (4) is shattered, for if empirical facts are the justification for logic, then logical proofs can then hardly be "superior" to empirical proofs. If the theorems of formal math are true only relative to both axioms *and* logic, then they are of of little value.

Given cultural variations in logic, the real question is NOT what sorts of logic are intuitively acceptable to Western scholars (or the indoctrinated) but which logic is *empirically* acceptable? That is, logic depends on physics, and specifically on the nature of time. That cannot be taken for granted just on the strength of some post-Nicene myths about creation and eternity, or on the related Western misunderstanding of calculus (which requires time to be like the formal real line, if physics is formulated using differential equations). As I have explained, empirically, time must be microphysically structured, and that gives us a quasi truth functional logic (like *catusokti* and *syadavada*), which is a quantum logic.

Further, as regards physics, we reject the church dogma (6) that there are laws of nature. This dogma arose from Aquinas' theology, that God rules with "laws of nature".[6] (This myth is involved in Western views about the calculus, which the West thought had to be "perfect", on the belief that God used the "perfect" language of mathematics to write the "eternal" laws of nature.)

We reject the myth (7) that formal math involves beauty or that theorem-proving involves aesthetics. Plato thought both music and mathematics arouse the soul, and hence recommended them for the young men of the Republic. However, the fact is that, today, the vast majority of young men love music but detest math. Aesthetics, unlike logic, is indeed a matter of intuition and perception, so the popular opinion must be respected over that of "experts", whose livelihood depends upon formal math and the myths about it. Though I would grant the aesthetics in Egyptian mystery geometry, as argued above, there is no evidence that any of it carried over into formal math within which lurks the ugly face of theology. Given this wide contrast in perceptions of math, formal math should *not* be publicly funded. It should certainly *not* receive public funds from the departments of science and technology, or atomic energy, but, at best, only from the department of culture.[7]

2. Practical value for science

Shorn of all those Western myths, all that remains is the practical usefulness of math for science, engineering, and commerce. I accept this criterion of practical usefulness, and it is for that reason that the vast majority study math today. But what is needed for practical applications is *calculation*, NOT theorem-proving. Further, empirical proofs in math are entirely acceptable for all practical applications (which concern the real world).

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5 C. K. Raju, "Logic", article in *Encyclopedia of non-Western science, technology and medicine*, Springer, 2008. http://ckraju.net/papers/Nonwestern-logic.pdf.

6 C. K. Raju, "Islam and science", keynote address. In *Islam and Multiculturalism: Islam, Modern Science, and Technology*, ed. Asia-Europe Institute, University of Malaya, and Organization for Islamic Area Studies, Waseda University, Japan, 2013, pp. 1-14. http://ckraju.net/papers/Islam-and-Science-kl-paper.pdf.

7 C. K. Raju, "Kosambi the mathematician" Special article, *Economic and Political Weekly* **44**(20) May16–22 (2009) 33–45.

In India, *ganita* developed always for its practical use, since the days of the *sulba sutra*-s. Unlike Western mathematics, *ganita* accepted both inference and empirical proofs.[8] Also, unlike Western math, it never made dogmatic claims to eternal truth or perfection. On the contrary, the *sulba sutra*-s explicitly admit to non-eternal (*anitya*[9]) knowledge which is further declared imperfect (*savisesa*[10]), an attitude which persisted for the next 2000 years. *Ganita* suits science, for its strength, like that of science, arises, not from bogus claims of eternal truth, but from this admission of fallibility and non-eternality or the possibility of continual improvement. Indeed, as clarified by my philosophy of zeroism,[11] all practically useful mathematics is just an auxiliary scientific theory.

We reject the myth (8) that formal math is essential for practical applications to science. All practical applications need calculation, so, from that perspective, calculation is "superior" and theorem-proving is an "inferior" ritualistic activity. For example, with stochastic differential equations, driven by Levy motion, one cannot formally prove the existence or uniqueness of solutions; nevertheless one can calculate solutions to reach practically useful conclusions about the stock market.[12] Likewise, it is of no use to *prove* the existence and uniqueness of something, say God, if one cannot *calculate* what God will do. Note, incidentally, that this focus on practical calculation (in *ganita* and zeroism) differs from the intuitionistic focus on "constructive" proofs, so zeroism is not intuitionism.

We reject the myth (9) that mathematics important for practical applications (such as trigonometry, calculus, probability) originated in the West. In fact, most of what is taught as school mathematics today (arithmetic, algebra, trigonometry, calculus, probability) concerns techniques of practical calculation which originated in India as *ganita* (with the implicit philosophy of zeroism), and were imported by the West for their practical value: arithmetic for commerce, trigonometry for navigation, calculus for astronomy and physics, probability for gambling or risk-taking. However, this inevitably led to a clash of epistemologies between *ganita* and mathematics,[13] as in Descartes' foolish but influential assertion that the ratios of curved and straight lines are beyond the human mind (i.e., that summing the infinite series for π is a supertask).

The term "West" has been defined (by historians and contemporary military strategists) in relation to the Western church. Because of church dominance, all Western knowledge (including knowledge of mathematics or science) was always under heavy pressure to be theologically correct. Thus, the clash of epistemologies was settled in the usual Western way. First, the imported *ganita* was wrapped in a false history (e.g. that Newton and Leibniz discovered/invented the calculus) to deny its non-Christian origins—a denial powerfully motivated by the Inquisition, as in the case of Copernicus or Mercator.[14] Second, *ganita* was coated with a veneer of metaphysics[15] (to do infinite sums in a way compatible

8 C. K. Raju, "Computers, Mathematics Education, and the Alternative Epistemology of the Calculus in the YuktiBhâsâ", *Philosophy East and West*, 51:3 (2001) pp. 325–362. http://ckraju.net/papers/Hawaii.pdf.

9 Apastamba *sulba sutra* 3.2.

10 Baudhayana *sulba sutra* 2.12.

11 "C. K. Raju, "Zeroism", article, to appear, *Encyclopedia of non-Western science, technology, and medicine*, Springer 2016. Also, C. K. Raju, "Probability in Ancient India", chp. 37 in *Handbook of the Philosophy of Science, vol 7. Philosophy of Statistics*, ed. Prasanta S. Bandyopadhyay and Malcolm R. Forster, General ed. Dov M. Gabbay, Paul Thagard and John Woods. Elsevier, 2011, pp. 1175-1196 (http://www.ckraju.net/papers/Probability-in-Ancient-India.pdf.).

12 C. K. Raju, "Computers, mathematics education...", cited above.

13 C. K. Raju,"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. Draft at http://ckraju.net/papers/Eternity-and-infinity.pdf. For an earlier account, see "Math wars and the epistemic divide in mathematics", chp. 8 in *Cultural Foundations of Mathematics*, cited above.

14 C. K. Raju, *Is science Western in origin?* Multiversity, Penang, and Daanish books, Delhi, 2010, reprint Other India Bookstore, 2014.

15 Incidentally, this real history provides a short answer to the "unreasonable effectiveness of mathematics"; the effectiveness came first, the metaphysics came later!

with the Western metaphysics of eternity). This *ganita*, coated with metaphysics, and packaged with a false history, was just declared "superior" and returned to India, as part of colonial education required for colonisation. The same old rhetoric of "superior" Western metaphysics is still used to support the present-day teaching of mathematics (e.g. claim of "rigorous" limits of university calculus). In fact, that Western metaphysics leads to inferior mathematics for purposes of science, as detailed below: the "understanding" it supposedly provides is delimited by a theological frame.

Thus, Aryabhata's invention of the calculus, in the 5th c., involved a novel method[16] of numerically *calculating* the solution of differential equations. An improved version of this numerical technique (and not theorem-proving) is still used for all practical applications of the calculus done on computers. However, computers *cannot* use "real numbers", and instead use floating point numbers which differ fundamentally from real numbers (e.g. associative law fails for floats[17]). Therefore real numbers (and limits) are NOT needed for practical applications of the calculus.

However, today formal mathematicians commonly claim that "real numbers are needed for calculus". We reject the myth (10) that formal reals, *R,* or metaphysical limits, are essential for the calculus. In fact, "real numbers" is an oxymoron: there is nothing real about real numbers, for no one can ever write down even a single real number such as π. (And an uncountable infinity of them is asserted to "exist"!) The so-called "real" numbers are pure metaphysics, and can NEVER be used for any practical application. Hence, contrary to the text book assertion that computer calculations are all erroneous compared to the "perfect" mathematics of formal reals, realistic zeroism rejects the idealistic claims of formalism as erroneous and a delusion.

Zeroism enables calculus to be done rigorously not only with floating point numbers, but also "non-Archimedean" fields larger than *R*. The West understood this last possibility only some 50 years ago, through non-standard analysis, which involves an overdose of metaphysics. However, one can dispense with non-standard analysis, and do calculus in fields which are "permanently" non-Archimedean. This was exactly how the infinite series of the calculus were summed in India. In Indian *ganita*, "non-Archimedean" fields originated in a very simple and intuitive way: polynomials, as first used by Brahmagupta, were called unexpressed (*avyakt*) numbers. This naturally led to "unexpressed fractions" or rational functions, which formally constitute a non-Archimedean field as is well known. Such a field admits infinities and infinitesimals. While such a field lacks unique limits, realistic zeroism enables one to rigorously deal with all problems of non-uniqueness in the natural way by discarding or zeroing small or infinitesimal differences irrelevant for the practical application at hand.

Not only is the metaphysics of formal reals not needed for calculus, it results in a calculus inadequate for physics because discontinuous functions cannot be differentiated. Ironically, this inadequacy was conceded in the West even before the formalisation of real numbers was completed with the formalisation of set theory. While the Heaviside operational calculus and the Dirac delta are today regarded as correctly formalised by the Schwartz theory, the troubles with that theory too had

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16 The method is today wrongly called "Euler's method". The usual apologia that Euler "independently rediscovered" this method does not apply any more than the present-day apologia that Michael Atiyah "independently rediscovered" Raju's theory of functional differential equations and quantum mechanics. Euler wrote a long article on Indian astronomy, so he was informed like Atiyah was. But Western mathematicians gang together to unethically hide this fact, and glorify themselves. For Euler, see, *Cultural Foundations of Mathematics*, cited above, chp. 3, "Infinite series and π". For the Atiyah case, see the misleading belated acknowledgment at *Notices of the American Mathematical Society* **54**(4) (2007) p. 472, which unethically suppressed the fact that Atiyah continued to claim credit even after he was directly informed of my book published ten years earlier. The judgment that it was unethical is at case no. 2 of 2007, http://www.scientificvalues.org/cases.html, and more details are at http://ckraju.net/atiyah/atiyahcase.html.

17 See e.g. "Computers, mathematics education...", cited above, which also has a sample C program to demonstrate this. For a detailed description of floats see my classroom "Lecture notes on C", posted at http://ckraju.net/hps2-aiu/floats.pdf.

commenced before its birth. For example, the renormalization problem of quantum field theory cannot be handled by the Schwartz theory because of the problem of products of distributions ("Schwartz impossibility theorem").

But similar problems also arise in classical physics. Briefly, the equations of physics are nonlinear (ordinary or partial) differential equations, but discontinuities arise, so those equations no longer make sense on the university calculus. They don't make sense with Schwartz distributions either, because nonlinearities result in products, not defined in that theory.[18] (The text-book trick of going over to integral equations does not actually work for various subtle reasons, such as those which tripped Riemann. Further, the discontinuities in question are not necessarily notional, as in Eulerian shocks in classical fluid dynamics. There are unavoidable discontinuities in real fluids with thermal conductivity and viscosity, and in general relativity, where there is no relativistic statistical mechanics to fall back upon.) While all these cases can be handled by non-standard extensions of Schwartz distributions, *together with empirical inputs*, as I once did,[19] they can all be better handled by using zeroism, and the original "non-Archimedean" *ganita* with which the calculus developed in India. In short, for practical applications to science, the Western formalisation of the calculus, and formal reals, result in a mathematics decidedly inferior to the original *ganita*.

To reiterate, the advantage of accepting *ganita* (together with an explicit philosophy of zeroism) and abandoning Western metaphysical prejudices is this: we get a *better* science. (At this stage, a common trick used to hang on to the myth is to cite personal ignorance: the myth believers claim Western math is useful for science, and simultaneously claim they are too ignorant of science to judge what is better or worse for science.[20] This only proves that ignorance is essential to maintain myths!) My new junctions conditions for relativistic shocks or the accompanying new conditions for shocks in real (viscous and thermally conducting) fluids are just one simple example of the results of an improved calculus.[21] Another example is the new technique of renormalization in quantum field theory. That these are generic advantages is clear from the application of this technique to modify Maxwell's equations to neatly solve the century-old unsolved problem of radiation damping.[22]

Newtonian gravity is perhaps the most ironic example of how the Western metaphysics of math hindered science. Newtonian physics failed because Newton, as the "second inventor" of the calculus, did not even understand it (both charges which he correctly made against Leibniz). Intensely religious, he thought mathematics was the "perfect" language in which God had written the eternal laws of nature (revealed to him). Hence, he tried to make calculus "perfect" by making time metaphysical. In the process, he took a step backward from his mentor Barrow's attempts to define a *physical* measure of time.[23] It was this *conceptual* failure of Newtonian physics (to define time measurement) which was corrected by special relativity.[24]

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18 C. K. Raju, "Distributional matter tensors in relativity", *Proceedings of the Fifth Marcel Grossman meeting on General Relativity*, D. Blair and M. J. Buckingham (ed), R. Ruffini (series ed.), World Scientific, Singapore, 1989, pp. 421–23. arxiv: 0804.1998. Or see appendix to *Cultural Foundations of Mathematics.*

19 C. K. Raju, "Products and compositions with the Dirac delta function", *J. Phys. A: Math. Gen.* **15** (1982) pp. 381–96. "Junction Conditions in General Relativity." *J. Phys. A: Math. Gen.* **15** (1982) pp. 1785–97.

20 E.g. the minutes of the conversation with a formal mathematician at the meeting of the ISSA in Vishkhapatnam, posted at http://ckraju.net/issa/conversation-draft-minutes.html.

21 "Distributional matter tensors in relativity", cited above. arxiv: 0804.1998.

22 For an easy pedagogical account of the connection, see C. K. Raju, "Functional differential equations. 3: Radiative damping" *Physics Education* (India), **30**(3), July-Sep 2014, Article 8. http://www.physedu.in/uploads/publication/15/263/7.-Functional-differential-equations.pdf.

23 C. K. Raju, "Time: what is it that it can be measured?" *Science & Education*, **15**(6) (2006) pp. 537–551. Draft available from http://ckraju.net/papers/ckr_pendu_1_paper.pdf.

24 C. K. Raju, *Time: Towards a Consistent Theory*, Kluwer Academic, Dordrecht, 1994.

Since Newtonian physics and Newtonian gravity come as a package deal,[25] Newtonian gravity too inevitably fails. On this line of thought, about a collective Western failure to comprehend the Indian calculus, the correct replacement for Newtonian gravity is not general relativity, but my retarded gravitation theory.[26] This new theory of gravitation corrects the long-known empirical failure of Newtonian gravity for the galaxy, a failure covered up with stories of invisible and undetectable "dark matter". It also corrects the *theoretical* failure of general relativity for the galaxy (for general relativity, asserted to be the ultimate theory, cannot be used to make actual *calculations* for the billion body problem required to study the galaxy).

The metaphysics of limits used in the calculus is also applied to probability in its measure-theoretic version. However, for the practical applications of probability to statistics, all we have is relative frequency. Using this to infer probability ("law of large numbers") is problematic since probability is only the *probabilistic* limit ("limit in measure") of relative frequency. Zeroism resolves this problem, for it enables us to discard small numbers in a context-dependent way, while admitting the fallibility of statistical inference. Also, probability is defined on a logic and, since logic is not unique, that logic need not form a Boolean algebra, as the example of quantum logic shows. The fresh understanding of probabilities, using zeroism, is useful for an understanding of quantum probabilities through the structure of time. Such an understanding is needed today to resolve the key technological problem of deocherence which dogs quantum computing.

The conclusion is that Western metaphysical prejudices about math, which were a veneer added on to an imported *ganita*, are NOT needed for its practical applications to science. On the contrary, that metaphysics actually hindered the development of science, and led to blind alleys. Hence, it must be discarded, and we must abandon formalism. What is needed for science is to accept *ganita* (and zeroism), and its method of calculation.

3. Pedagogy

Perhaps the greatest beneficiaries of such a move (to accept *ganita* and abandon formal math) will be school children. The statement that 2+2=4 admits of a simple understanding in natural language (which implicitly employs zeroism), where the abstraction "2" is understood ostensively by empirical referrants, exactly like the abstraction "dog". However, formalism turns "2" into a very difficult abstraction, disjoint from experience, and involving set theory. Since axiomatic set theory is too difficult to teach to children, they are today taught set theory without defining a set!

That sort of indoctrination ("for better understanding"!) suits colonial "education" which grew from church "education" *designed* to teach ignorance and blind dependence on authority.[27] Eventually, students are indoctrinated into calculus-with-limits in schools (and most colleges) without teaching formal reals. (Or sometimes taught formal reals without teaching the requisite formal set theory.) Naturally, many students reject the lack of clarity in such "teachings". Hence, most abandon math before reaching calculus. They wrongly blame themselves or their teachers, when what is at fault is the subject of formal math, with all its useless metaphysics.

Teaching school math the way it actually originated in the non-West makes math easy, as has been demonstrated by my pedagogical experiments, particularly the 5-day course on calculus,[28] which

25 *Time: Towards a Consistent Theory*, chp. 2

26 For an easy pedagogical account, see "Functional Differential Equations. 4: Retarded gravitation" *Physics Education* (India) **31**(2) April-June, 2015, http://www.physedu.in/uploads/publication/19/309/1-Functional-differential-equations-4-Retarded-gravitation-(2).pdf.

27 C. K. Raju, comment on "Education as counter-revolution". Edited and republished as an article "Education and Church: Decolonising the hard sciences" in *Frontier Weekly* **46**(7) 25-31 Aug 2013. Original posted at http://ckraju.net/papers/Education-and-counter-revolution.pdf.

28 C. K. Raju, "Teaching mathematics with a different philosophy. Part 1: Formal mathematics as biased metaphysics."

enables students to solve problems too hard to be solved by those with just a course in university calculus. Thus, not only do we get a better science, we also get a better math pedagogy by abandoning formal math, and accepting *ganita* (together with zeroism).

Similar remarks apply to probability. Social scientists need it, but find the complexities of the Lebesgue integral and measure theory offputting and pointless metaphysics.[29] A decolonised course has been designed[30] to teach statistics to social scientists, using zeroism (and open source software).

Finally, I reject the colonial myth that to validate knowledge it is necessary to obtain the prior approval of Western authorities, who will judge it in secret (secretive "peer" review).[31] It is laughable that science requires anything to be done secretively: secretive review was a church technique to preserve myths by using pre-censorship to prevent the public articulation of dissent. Hence, such secretively reviewed academics leads only to dark matters! Let Western (or colonised) academics come out of their church cocoons, and learn to debate publicly, and transparently, without the cover of secretive manipulations by those in authority. Public debate requires real knowledge, so it exposes both myth and the myth-keepers. Those unwilling to debate publicly may hang on to their faith, or vested interests, but only as a private matter, not acceptable in the public domain. And the fact is that Westerners have persistently failed to publicly address any of this critique for the last two decades. So, it is high time to leave behind the West and its myths and metaphysics of math, and move on.

4. Conclusions

Formal math is culturally biased metaphysics, supported by church dogmas and myths. This sort of math is today taught as a compulsory subject to children in school, so it becomes an unsuspected vehicle for subtle church propaganda. Forcing subtle biases in the minds of children is unethical and unconstitutional. Hence, we should stop teaching religiously-biased formal math in schools and teach secular *ganita* instead.

Most people learn math for its practical value to commerce, science, engineering etc. Practical value derives from the calculations of *ganita*, not formal proofs. Most math taught in schools historically originated as *ganita*, and acquired a veneer of dogmatic metaphysics along with a false history after being imported by West. Reverting to *ganita* (together with zeroism), rejects that veneer of metaphysics, and false history, but retains practical value. In fact, church dogmas in mathematics have hindered science, as in the conceptual confusion about time in Newtonian physics arising from dogmas about perfection in calculus. Rejecting those dogmas actually *enhances* practical value (as in the new theory of retarded gravity).

Teaching *ganita* the way it historically developed in the non-West, minus the veneer of confused metaphysics it acquired in the West, also has the advantage that it makes math easy and intuitive, and leads to a better understanding. Hence, we must henceforth adopt *ganita* (together with zeroism) and reject formal math.

Science and Culture **77** (7-8) (2011) pp. 274–279. http://www.scienceandculture-isna.org/July-aug-2011/03%20C%20K%20Raju.pdf, arxiv:1312.2099. Part 2: Calculus without limits", *Science and Culture* **77** (7-8) (2011) pp. 280–85. http://www.scienceandculture-isna.org/July-aug-2011/04%20C%20K%20Raju2.pdf. arxiv:1312.2100. Also, "Calculus without limits: report of an experiment", *Proceedings of the 2nd People's Education Congress*, 2010, http://ckraju.net/papers/calculus-without-limits-paper-2pce.pdf.

29 Incidentally, proof by contradiction is essential to prove the (metaphysical) existence of a Lebesgue non-measurable set.

30 "Decolonisation of education: further steps", paper for the meeting on "Decolonisation and leadership", Nottingham University, Malaysia Campus, Jan 2015. Draft posted at http://ckraju.net/papers/KL-abstract-and-draft.pdf. For an earlier account, see "Decolonising math and science education". Paper for a conference on education, Delhi University. Also in: *Ghadar Jari Hai* **8**(3), 2014, pp. 5-12. http://www.ghadar.in/gjh_html/?q=content/decolonising-math-and-science-education.

31 C. K. Raju, *Ending Academic Imperialism*, Citizens International, Penang, 2011. http://multiworldindia.org/wp-content/uploads/2010/05/Academic-imperialism-final.pdf.