Black thoughts matter: decolonized math, academic censorship, and the "Pythagorean" proposition

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Bio: C. K. Raju helped initiate history and philosophy of science in India (at CSC), authored an acclaimed Sage book, and edited a philosophy journal. He also helped build the first Indian supercomputer, taught and researched in university departments of math, statistics, and computer science, and wrote a book on physics. He is President Elect of the Indian Social Science Academy.

Abstract

In post-apartheid South Africa whites dominate academics and black students are agitating for decolonization. Decolonization requires contesting the false history of science used to set up colonial education essential to colonization—the same false history which was used to morally justify racism, by asserting the non-creativity of blacks. The "evidence" for this false history is often faith-based, so white-controlled academics disallows any open discussion. Further, this false history is sustained by another trick: a little known interplay between history and philosophy. Thus, geometry has been credited to Greeks on the ground that they had a "superior" philosophy of mathematics as deductive proof. In fact, the "Pythagorean" proposition had no valid deductive proof before the 20th c. Further, this claim of philosophical "superiority" was never academically debated, and is not allowed to be. A recent attempt to explain the falsehood of this claim, along with the *counter*-evidence against purported Greek achievements in math, was publicly censored. In fact, in Egypt, Iraq, and India, there was a *different* and immensely superior understanding of the "Pythagorean" proposition, which superior way was not grasped in the West, resulting in its persistent navigational problems until the late 18th c.

Keywords and key phrases: apartheid, racist history, decolonization of math, Pythagorean theorem.

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1. Background

Post-apartheid South Africa

In post-apartheid South Africa, blacks do have access to the university, but little success. The situation is racially so skewed (Council on Higher Education 2013), that “under 5% of African and colored youth are succeeding in any form of higher education” (p. 15). This perpetuates apartheid in another guise, for, without success in higher education, blacks remain confined to low level jobs. No doubt poverty is a reason for the poor success rate of blacks. However, given that the academia still remains predominantly white-controlled, much as it was when apartheid ended two decades ago, there is a strong suspicion that the lingering, subterranean racism of the academia plays a role in this appalling rate of success of black students.[1]

One black student expressed his frustration by hurling a pail of excrement at the statue of Cecil Rhodes in Cape Town. That act sparked a widespread agitation, known by its hashtag #RhodesMustFall. Rhodes' statue was later pulled down (in Cape Town, but not in Oxford). But the movement kept growing, leading to a demand for decolonization of universities, and lower fees. Decolonization cells have been set up in various universities, making decolonization a buzzword in South African universities today. However, one may suspect that many in the academia, while paying lip service to decolonization are, in reality, opposing it, a suspicion strengthened by recent events.

Decolonization and the history and philosophy of science

Now, already for the past several years, the Multiversity, in Malaysia, India, Iran, has been working on the decolonization of universities. Macaulay (Raju 2011a) used a false history of science—that science was a Western creation—to justify imposing colonial education needed to win the consent of the ruled. That is, colonialism involved a strategy similar to what was used for racism: for, a long string of Western philosophers, Hume (1854), Kant (2011),[2] Hegel (Bernesconi 2003), etc. used the same false history to morally justify racism by asserting the non-creativity of blacks.

Hence the conclusion: that to undo both colonialism and racism one must start by teaching a more honest history of science. This was put into practice. An international workshop was convened in 2012 to draw up an alternative curriculum in the history and philosophy of science (http://ckraju.net/blog/?p=73). The resulting new curriculum was successfully taught in AlBukhary International University, Malaysia. A video interview of students' reactions is available.[3]

Greek glorification vs Afrocentrism

Now, a long battle has been waged against Greek glorification by George James (2001), Cheikh Anta Diop (1974), Martin Bernal (1987), Asante (1998, 2000, 2003, 2007, 2009), Mazama (2003), and others, and this has been resisted by Mary Lefkowitz (1996) and others. A key issue here is that of Egypt vs Greece: was a pseudo history of Greeks used to appropriate the achievements of Kemet, or black Egypt, and then used to declare blacks as inferior? (Asante and Mazama 2002, Nobles and Nobles 2005). On the double standards characteristic of racism, the pseudo-history of Greeks has been used as self-proving.

For example, James (2001) argued, in effect, that much of what is today attributed to Aristotle derived from the Great Library of Alexandria. Lefkowitz (1996) triumphantly counters this by asserting that

Aristotle died before the Great Library of Alexandria was established. Obviously, however, the books of the Great Library were not created in an instant, and most existed from earlier. Setting aside this devious use of chronology, Lefkowitz’s claim tacitly uses the pseudo history that Aristotle was the actual author of all or most of the texts today attributed to him. What is the evidence? In fact, the West learnt of Aristotle from Muslims, during the Crusades, some 1500 years after Aristotle. Muslim philosophers valued the “theology of Aristotle”, but that is today attributed by Western historians to “Neoplatonist” authors, such as Plotinus and Proclus, who came more than 500 years after Aristotle, and whose work definitely derives from Egypt (Raju 2012c). Therefore, hard evidence is needed to establish that a work traditionally or pseudo historically attributed to Aristotle actually originated with him. Mere “authoritative” opinion cannot be validly substituted for evidence, as Lefkowitz does.

Amazingly, in the above debate concerning Egypt and Greece, a key issue (Martin Bernal, personal communication, 9 Jan 2010) is whether, despite the pyramids, the so-called Pythagorean theorem was known in Egypt (Gillings 1972; Lumpkin 1997). Now, Pythagoras is myth, not history, and there is nil serious evidence to connect the proposition to him. However, in this article we go a step further, and raise a question that nobody has yet asked: was the so-called “Pythagorean theorem” properly understood in the West? Thus, the term “theorem” suggests a deductive proof, but, as was admitted over a century ago, the West was mistaken in believing there was any valid pure deductive proof of the “Pythagorean” proposition prior to the 20th c. Further, as we explain below, the European navigational disasters, from the 16th to the 18th c., related to a poor understanding of the “Pythagorean” proposition. This sounds the death-knell of Greek glorification.

Finally, history concerns the future, not the past. So, are there any contemporary consequences *for math and science*, of a corrected history? There are: for example, as argued below, teaching Egyptian cord geometry has demonstrable advantages over the present-day teaching of school geometry. Though a full answer involves technicalities beyond the scope of this article, let us briefly see how this happens.

The inter-relation between history and philosophy

So, how could a revised history affect science and math, *per se*? First, we must note the mutual interaction between (a) the history and (b) the philosophy of science. For example, today, why do historians credit geometry to Greeks, and not to Egyptians as Herodotus did? Because of the explicit claim (Rouse Ball 1960; pp. 1-2) that Greeks did something philosophically special: the claim that Greeks gave “superior” deductive proofs which is what “real” geometry is about, as distinct from what is contemptuously dismissed as mere empirical “land surveying”. It is on this *philosophical* ground that Clagett (1999) most recently asserts credit for the Pythagorean theorem must go to Greeks: he says, “there have been exaggerated claims that Egyptians had knowledge of the Pythagorean theorem which is, of course, a formal Euclidean theorem of the *Elements*” (p. 9).

The claim of a “superior” way of doing mathematics is itself an admission that there are at least two ways to do math: the way that Egyptians and others did math was declared “inferior” and did not count as “real” geometry, a claim repeated *ad nauseum*. In other words, the purported universality of math is a normative one, not a factual one: one particular way of doing math is declared “superior”, *hence* the universal norm. This claim of “superiority” was never argued out. In fact, when the other side tries to get a word in, the strategy is to censor it out, for there is no other way to maintain that claim of “superiority”. This way of doing math was globalized by colonialism and is the basis of the philosophy of formal math, used to teach math in schools and universities today. Nevertheless, one has to maintain a clear distinction between something made global by the political process of colonialism, and something which is naturally universal. Present-day math is *not* universal.

Decolonized math

The above relation between history and philosophy provides the way to decolonize math. So, how will

one decolonize 1+1=2? By making 1+1=3? No. As explained above, the philosophy of math is not unique: there are at least two ways of doing 1+1=2. An “inferior” and commonsense way which everyone learns, as in one dog plus one dog equals two dogs, though the two dogs need not be exactly alike. The other is the “superior” metaphysical way used by, for example, Whitehead and Russell who, in their *Principia,* use 378 pages to prove 1+1=2. Most people are unaware of even the existence of the second way of doing 1+1=2, and consequently they are unaware that their understanding of 1+1=2 is dubbed inferior and not “real” math.

The question is: do we accept these categorizations of “inferior” and “superior” math? If not, which one of these two ways of doing 1+1=2 should be used and taught? And what difference does it make? The first difference it makes is political. Since few people understand the “superior” 378 page way of doing 1+1=2, therefore accepting that way as “superior” creates a strong *epistemic dependence*: even to understand a simple thing like 1+1=2, most people in the world need the opinion of an expert. From a position of ignorance how can they validly judge who is a good “expert”? They cannot; they proceed on trust. That trust can be easily misguided by propaganda and colonial practices. Thus, the colonially educated are indoctrinated to believe that (a) only Western (or Western-approved) experts are “reliable sources”, (b) all others are to be actively distrusted. Hence, for the colonized, “expertise”, and the validity of all knowledge, *must* be decided by reference to “reputed” Western (or Western-approved) experts. This epistemic dependence has *political* value, but for the master not the slave. It also provides an easy way for the master to control all knowledge, such as knowledge of history. However, doing 1+1=2 in this complicated “superior” way offers no extra practical value for science or everyday commerce.

Indeed, adding mountains of metaphysics to simple things may diminish practical value because it may add wrong hypotheses. Thus, the infinite series of the calculus indubitably originated in India (Raju 2007) (by the 14th c.). It is another story that this was stolen by the Jesuits in the 16th c., for the related

knowledge of precise “trigonometric” values was badly needed for European navigation. The immediate point is this: those who developed the infinite series *had* to have their own epistemology. However, this epistemology was not understood (Raju 2007; Raju 2015a)[4] by Newton and Leibniz to whom the calculus is attributed today, because Europe was then backward in mathematics. Berkeley (1734), for example, declared Newton's fluxions and Leibniz's infinitesimals as “Ghosts of departed Quantities” (section XXXV), and refused to accept the calculus as valid math. In implicit acceptance of this critique, attempts were made in later centuries, to understand the calculus using Dedekind's cuts (“real” numbers) and Cantor's set theory needed for that, but Cantor's theory was riddled with paradoxes, such as Russell' paradox. It was only ca. 1940 that set theory was formalized, and the West finally developed an “acceptable” way to understand those infinite series of calculus.

This understanding involved tons of metaphysics—the metaphysics of formal real numbers, needed to sum infinite series, and the formal set theory needed for that. It added hugely to the difficulty of calculus but zilch to its practical value. To send a spacecraft to Mars, NASA still uses (a minor refinement of) much the same numerical method developed by Aryabhata, and today wrongly named as “Euler's” method of numerically solving ordinary differential equations (Raju 2007; chp. 3). Rejecting the redundant metaphysics makes calculus easy, as has been demonstrated by pedagogical experiments to teach decolonized calculus (Raju 2011b,c) by reverting to (a modernized version of) its original epistemology, now called zeroism (Raju 2014a).

Since calculus is central to the formulation of science, changing the understanding of calculus, by eliminating Western metaphysics in it, also changes science. For example, changing Newton's understanding of the calculus also changes his theory of gravity in a way that leads to experimentally refutable consequences (Raju 2012b). This, in outline, was the basis on which the decolonization of math and science was proposed, leading to real differences in math in the classroom (it makes math easy), and science in the laboratory.

Cord geometry

In fact, the development of calculus was facilitated by use of a flexible string or cord to do geometry, as was done in both Egypt (Clagett 1999; Fig. IV.23, p. 437)[5] and India (Sen & Bag 1983). The use of a flexible string enables us to give a direct empirical meaning to the circumference of a circle, which is a curved line. The related number (π) is found in problems 50 and 48 of the Rhind mathematical papyrus (Clagett 1999) and the Indian *sulba sutra*-s (Sen & Bag 1983; Apastamba 3.2). The infinite series of the calculus (“Leibniz series”) developed through related attempts to make more precise calculations of this number. The octagon approximation to the circle used in the Rhind papyrus (figure in problem 48) was slightly modified and turned into a recursive method, by repeatedly “cutting the corners” (Raju 2007; chp. 3) of a square to get an octagon, then 16-gon etc., and approximate a circle to thus develop the infinite series for its circumference. The ratio of the circumference to the diameter is a number today denoted by the Greek letter π (for perimeter) on the ridiculous faith-based history that a text from 1800 years after Archimedes is an exact and verbatim account of what Archimedes [from Alexandria] did (as Lefkowitz (1996) also asserts).

In contrast, the school curriculum in geometry teaches the use of a geometry box, in imitation of the West. The geometry box is inferior to the string for it has no instrument with which to measure curved lines such as the circumference of a circle. The string is a complete replacement for all the instruments in that box (Raju 2009a). Using the string in the school classroom also leads to greater conceptual clarity in elementary geometry notions such as an angle which cannot be properly defined and explained using only straight lines, as is wrongly done today (Raju 2014b). Therefore, one ought to reject the geometry box and revert to the string, as the right way to teach practical geometry in school. Pedagogical experiments on this are ongoing.

The recolonization of math

To return to the situation in South Africa, while one part of South Africa is desperately exploring decolonization, there is another part which feels threatened and is overtly or covertly trying to derail that process which threatens to break academic apartheid, and tear up its root justification: racist history.

Now, it is an old academic trick to just attach the latest buzzword to whatever one has been doing, to promote it. In this spirit, Brodie (2016) wrote an article ostensibly on decolonization of mathematics. She completely ignored all past work on the decolonization of mathematics, and instead went back to the racist history of mathematics: she asserted “Much, though certainly not all, mathematics is the work of dead white men”. She did not even remotely suggest that a possible remedy was to explore a change in mathematics *per se*, or its philosophy, which might just reflect the prejudices of those “dead white men”. Instead, the solution she suggested was to change the psyche of the black students (and women), implicitly to make them think more like the “dead white men”, who created the subject, and thus turn them into good mathematicians! This was the classic colonial line, to use colonial education to produce white minds in black or brown skins, enslaved minds who would hence help run colonial empires.

My article in response was so brief (a thousand words) that it is reproduced in its entirety below. The *Conversation* style required the use only of hyperlinks; in the following, these have been changed to regular citations, or included in text, or given as footnotes.

2. To decolonize math stand up to its false history and bad philosophy

A false history of science was used to initiate colonial education (Raju 2011a) in support of

colonialism. This false history persists. In a recent article about decolonizing mathematics (Brodie 2016), for instance, Professor Karen Brodie asserts that “Much, though certainly not all, of mathematics was created by dead white men.”

This is not true.

A false history

Consider the most elementary mathematics of fractions. Did the white man invent it? No. The Rhind papyrus (Clagett 1999) shows that black Egyptians knew about fractions from at least 3700 years ago. Moreover, Greeks and Romans did not: there is no systematic way to represent fractions in traditional Greek and Roman arithmetic. Europe imported the arithmetic of fractions, and it came into the Jesuit syllabus only around 1572 (Clavius 1575?; Clavius 1583; Phillips 1941),[6] and the white man finally started learning what Ahmose the scribe was teaching black children from 3000 years earlier.

What mathematics could “dead white men” have created without even a knowledge of fractions?

Of course, Western historians have long claimed that “real” math was invented by Greeks: Pythagoras, Euclid and so on. However, Pythagoras is myth (Raju 2014b) and there is no historical evidence for Euclid (Raju 2009b) as I’ve explained in my book *Euclid and Jesus* (Raju 2012c)

The “evidence” for Euclid is so thin, that I’ve instituted a challenge prize (http://ckraju.net/Euclid/) of around R40,000 [USD 3300] for serious evidence about Euclid. This stands unclaimed and has done for several years.

Further, though the text *Elements* (which Euclid supposedly wrote) comes from Alexandria in Africa, its author is commonly visualized (http://www.storyofmathematics.com/hellenistic_euclid.html) as a white man. But it is rather more likely that the anonymous “author of the Elements” was a black woman (http://ckraju.net/Euclid/).

When this is pointed out, some people try to save the myth: they say they don’t care about the author, only the book. However, it is another false Western myth that the book *Elements* is about deductive proofs. The actual book contains no pure deductive proofs. Its very first proposition is proved empirically, as is its fourth proposition (the side angle side theorem), needed for the proof of its penultimate proposition (“Pythagorean proposition”).

Deductive proof doesn’t lead to valid knowledge

Stripping off the false history exposes the central philosophical claim: that “real” math is about deductive proofs which are infallible and lead to “superior” knowledge. However, that claim too is false: deductive proofs are fallible. So an invalid deductive proof can be easily mistaken for a valid one. For centuries, the most authoritative Western scholars collectively made this mistake, when they wrongly praised “Euclid’s” *Elements* as a model of deductive proof.

Worse, even a validly proved mathematical theorem is only an inferior sort of knowledge, since we never know whether it is valid knowledge. For example, the “Pythagorean theorem” is not valid knowledge for triangles drawn on the curved surface of the earth. However, Europeans kept applying the “Pythagorean theorem” to such triangles to determine latitude and longitude on their navigational technique of “dead reckoning” (Raju 2007; chp. 5). This led to centuries of navigational disasters and made navigation – and determination of longitude – the key scientific challenge for Europeans from the 16th to the 18th centuries.

In fact, a mathematical theorem need have *no relation at all* to valid knowledge. For example, we can easily prove as a mathematical theorem that a rabbit has two horns: 1. All animals have two horns. 2. A rabbit is an animal. 3. Therefore, a rabbit has two horns. This is a valid deductive proof, but is the conclusion valid?

Mere deductive proof does not lead to valid knowledge. We must check whether the assumptions are true. In this case the assumptions are false: simply point to an animal which has no horns. However, formal math forbids such commonsense, empirical proofs, based on its central dogma that deductive proofs are “superior”.

Anyway, the postulates of formal mathematics, say set theory, cannot be empirically checked. So, formal mathematics is pure metaphysics. The only way to check its assumptions is to rely on authority – and in practice we teach only those postulates approved by Western authority. For example, calculus is done with formal real numbers (and not Indian non-Archimedean arithmetic, or floating point numbers used in computer arithmetic). School geometry is taught using Hilbert’s far-fetched synthetic postulates, not Indo-Egyptian cord geometry (Raju 2009a).

A slave mentality

Thus, formal mathematics creates *a slave mentality*. It creates a person who blindly relies on Western authority and conflates it with infallible truth. So finding better ways of inculcating that slave mentality – teaching the same maths but differently, as Brodie proposes in her article – is absolutely the last thing we should do.

False claims of “superiority” are a trick to impose Western authority, exactly as in apartheid. Everyone understands 1+1=2 in a commonsense way. But Whitehead and Russell took 378 pages in their *Principia* to prove 1+1=2. Declaring such mountains of metaphysics as “superior” knowledge has political value. People who cannot understand those 378 pages “needed” for 1+1=2 are forced to trust an “expert”.

The entire colonial tradition of education teaches us to trust only Western-approved experts, and distrust everyone else. This creates epistemic dependence for even the simplest things like 1+1=2,

making epistemic dissent impossible.

But epistemic dissent is central to decolonization. And much work has already been done to decolonize mathematics.

A successful alternative

There is an alternative philosophy of mathematics (Raju 2001) consolidated in my book *Cultural Foundations of Mathematics* (Raju 2007) and now renamed zeroism (Raju 2014a)

It rejects the Western metaphysics of formal mathematics as religiously biased (Raju 2011b) since the days of Plato, who related mathematics to the soul. Actual teaching experiments have been performed with eight groups in five universities in three countries – Malaysia, Iran (http://ckraju.net/blog/?p=84) and India (http://ckraju.net/blog/?p=83).

This decolonized math is so easy that the calculus can be taught in five days (http://ckraju.net/blog/?p=34). Work on this approach to decolonizing mathematics and science (Raju 2012a) has been reported in various meetings on decolonization organized by the Multiversity (Alvares & Faruqi 2012). It was publicly discussed in newspapers,[7] and blogs, and prominently reported in newspapers,[8] magazine articles (Raju 2014c) interviews[9] and videos (http://tvmultiversity.blogspot.in/2014/02/c-k-raju-interviewed-by-claude-alvares.html).

Decolonized math rejects the redundant metaphysics of formal math as inferior knowledge. It reverts to a commonsense practical philosophy of mathematics as a technique of approximate calculation for practical purposes. By making math easy, it enables students to solve harder problems (Raju 2006a) that are usually left out of existing courses. It also leads to a better science, the simplest example being a better theory of gravitation (Raju 2015b) arising from correcting Newton’s wrong metaphysical presumptions about calculus.

In short, math **can** be decolonized. The simple way to do it is to have the courage to stand up to its false Western history and bad Western philosophy, and focus solely on its practical value.

Author’s note: Publication details for cited references are available here (http://ckraju.net/papers/Reading-list-Bengaluru.html).

[The article included an embedded video (https://www.youtube.com/watch?v=IaodCGDjqzs) of a talk (http://ckraju.net/papers/Calculus-story-abstract.html) I gave at MIT, Cambridge, Mass., explaining, how a decolonized math works for better science.]

The argument from logic

Because the article was limited to 1000 words, some key arguments were included only indirectly through cited references. One is an argument from logic. When formalism started with Hilbert and Russell, at the turn of the 20th c., the West knew of only one logic, which was *hence* ignorantly believed to be universal. The plural logics is flagged as ungrammatical in the English language, to this day. Reasoning based on this 2-valued logic was also the “reason” involved in the influential post-Crusade rational theology of the church, for it was believed that this logic was binding even on God, in the sense that God could not create an illogical world, but could create the facts of his choice (Raju 2006b). However, the collective ignorance of Western scholars and theologians is not a valid reason to declare something as either universal or as certain truth. Different systems of logic, such as the Buddhist logic of 4-alternatives, and the Jain logic of “perhapsism” existed from long before even the historical Aristotle (Raju 2003; Raju 2008). Further, quantum mechanics developed after the philosophy of formalism, and quantum logic is not 2-valued, but is quasi truth-functional (Raju 1994; chp. 6b). In fact, an infinity of different logics are possible. This knocks down a key basis of formalism that logical truths are certain. Using a different logic would change the theorems which can be derived from a

particular set of postulates: so there is is *no* necessary truth even in the connection between postulates and theorems (Raju 2006b).

Of course, one might assert that the world obeys 2-valued logic, a thing which is here is not there. But advocating an empirical basis for logic knocks down formalism, for, if logic is not God-given, as Western scholars believed, but is itself decided by fallible empirical methods, how can deductive proofs be *less* fallible than empirical proofs? Further, empirically, 2-valued logic is at best an *approximation* which neglects minute errors, as, for example, quantum mechanics shows: a tiny electron which is here may also simultaneously be there. Western historians have wrongly been asserting the “inferiority” of empirical proofs, based merely only on their ignorance of other logics!

There are other common arguments used to defend formal math, such as the argument from aesthetics which I have earlier repeatedly rejected as a myth (Raju 2015c) : aesthetics did apply to the Egyptian mystery geometry which Plato recommended for arousing the soul. But formal math is different: most students detest it, though they still love music (which Plato recommended along with math).

3. The fallout

The above article against racist history and formal math was published in *Conversation*, on 24th Oct 2016, and immediately went viral. Many whites, even those who were not explicit racists, were outraged by the taking down of figures such as Pythagoras and Euclid as myth, something more painful to them than felling the statue of Rhodes. Their rage and frustration grew as they realized it was impossible to refute my thesis on academic grounds. (In particular, my challenge prize of USD 3,300 for serious evidence about Euclid stayed absolutely unscathed.) Hence, they ran a troll campaign of bullying, calumny, vilification and abuse.

The existence of this post-apartheid troll army exposed the lingering resentment against the fall of apartheid, and is reminiscent of the Ku Klux Klan which emerged after the American Civil War. Where

the post-emancipation Klan resented political equality for blacks, the post-apartheid trolls resent academic equality for blacks. Where the Klan shot people to assert white political supremacy, the troll army shoots down any anti-racist thoughts in cyberspace to re-assert white academic supremacy. Like the Klan, this troll army seems to be loosely organized, but acting with a common purpose to retain the power whites lost with the demise of apartheid. However, unlike the Klan, these are people who still control academic power in South Africa today, and are hence capable of vast mischief. Historians should have long ago suspected the persistence of such an underground resistance: it was naive to suppose that the end of political apartheid meant that all people instantly abandoned their racist prejudices.

Succumbing to the pressure exerted by the white troll army, in a brazen act of censorship, the Africa editor of the *Conversation* removed my article. Removing the article was an indirect admission that censorship was the only way to save the racist history of “dead white men” being the originators of math, against my challenge prize for “Euclid”. Had an easy rebuttal of the article been possible, at the academic level, *Conversation* would have carried it to better inform its readers.

Privately, the excuse given was that I had cited only my publications to back up my key points. Evidently, the editor of *Conversation* was ignorant that Einstein’s celebrated relativity paper of 1905 has no references at all, so this newly invented silly rule would have outlawed it! Indeed, she did not wonder how so much of my published work got past so many referees: the fact that I was non-White was enough to invoke prejudice to shoot it down. On the other hand, understood as “too many self citations”, the excuse given was manifestly false as can be seen by examining the article. Had the excuse been serious, the editor should have asked me to explain, or supply further references, not pulled down a popular article. The full details are discussed on my blog.[10]

This is a clear example of how whites in South Africa are brazenly using their control over academics to promote not only false history (“math is the work of dead white men”), but also palming of

recolonization solutions (“hence change the psyche of blacks and women to teach them math”) as decolonization. The plight of black students in the classroom, struggling to pay high fees, and afraid of failure, can only be imagined. While such subterranean racism of white academics cannot be suppressed like the Klan, strong measures are needed to ensure the freedom of academic expression against racist history, as a statutory right, for that freedom from academic apartheid must precede any attempt at decolonization.

4. The “Pythagorean theorem”

So, how does a decolonized math affect stock beliefs about the “Pythagorean theorem”? Recall that the “theorem” is credited to Greeks not Egyptians, on the historical + philosophical grounds that “it is a formal Euclidean theorem of the *Elements*”. In my *Conversation* article, this claim was decoded as a complex bunch of lies: historically, there was no Euclid and no formal theorems in the *Elements.* There is no evidence for, and ample *counter*-evidence against both claims. Further, the philosophical claim of “superiority” of deductive proofs was as flimsy as claims of racial superiority, to which it was analogous. The “Pythagorean theorem” understood as a formal mathematical theorem, far from being a certain truth, is actually *invalid* knowledge, for right-angled triangles drawn on the curved surface of the earth. Mistaking that invalid knowledge for infallible truth led Europeans to centuries of navigational disasters.

Many people do not get the point of that brief remark: they argue that the “Pythagorean theorem” was valid but *approximate* knowledge for navigational triangles. But the whole basis of asserting the Greek claim on geometry over the Egyptian was that formal mathematical theorems lead to *exact* knowledge, “superior” to approximate knowledge. So, if we get only *approximate* knowledge, even from all that prolix, formal theorem-proving, that claim of superiority was false, and that falsehood which has been reiterated for centuries must first be admitted as such.

In fact, as exact knowledge, the “Pythagorean theorem” does *not* apply *anywhere* in the real world. Thus, in the real world, the closest thing to a straight line is a ray of light, or the path of an electron, which is a curved line on general relativity, and a wavy line on quantum mechanics. It was the idle boast of “superior”, “exact” knowledge, in some imaginary metaphysical world, which did European sailors in.

Further, a vague claim of “approximate” knowledge” is mere apologia, of no practical use at all, unless we are able to specify the *degree* of approximation (which first requires an explicit admission that we have nothing better than approximate knowledge). Telling a shipwrecked sailor that “we are approximately close to land” is meaningless, for “approximately” may mean that we are 3 km from land or 300 km, a difference between life and death. Therefore, it is not enough to know the surface of earth is curved, we should be able to *specify* the radius of the earth (regarded as approximately a sphere). The point was made forcefully by the mathematician Brahmagupta (1966 [7th c.]) [11] who asserted, *“ignorance of the radius of the earth makes longitude calculations futile”*.

Recall that European navigators faced the famous longitude problem, which led to navigational disasters: for centuries, and European governments offered large rewards for its solution from the 16th to the 18th c. The “longitude problem” arose just *because* Europeans did not know the accurate radius of the earth: Columbus' figure was off (Rizvi 1979) by 40%, Newton's first estimate by 25%. Europeans did suspect their estimates of the size of the earth were wrong, and that this inaccuracy was responsible for navigational disasters, *hence* the Portuguese law of 1500 banning the carrying of globes aboard ships.

However, this ignorance was unique to Europeans. From at least a thousand years before Columbus, others such as Aryabhata, Khalifa al Mamun, and al Biruni were better informed. The last used Indian techniques, but expressed the result in units of Arabic miles, which can be accurately correlated with the British mile, so we know his value of the radius of the earth was accurate to within 0.1%. I have

discussed the details of the instruments used for the precise angle measurements needed to arrive at this accuracy (Raju 2007; chp. 5).[12]

Instead of glorious tales of how Harrison's chronometer solved the longitude problem, to learn from history we need to ask: why did the Europeans alone have a “longitude problem”? Why were they practically the only one's ignorant of the earth's radius? (In answering this question, for simplicity I will set aside the matter of the flat earth in the Bible, and the related issue of church coercion. I will also set aside the matter of why even *latitude* determination was difficult for Europeans, in the 16th c., prior to the Gregorian reform because of their erroneous religious calendar, erroneous due to ignorance of fractions. Note that the Gregorian reform was not understood and not accepted in Protestant Europe until 1752.) The simple answer to the question then is this: Europeans were ignorant of the exact radius of the earth (until Picard in 1672) *just because Europeans had a very limited understanding of the “Pythagorean” proposition.*

A far superior understanding prevailed in the Iraqi, Egyptian, and Indian traditions. But we must first understand that the Western way to state the Pythagorean proposition is inferior and *not* the only way. The “Pythagorean proposition” was stated and understood *differently*, in other traditions. A first simple difference is that it was stated using the *diagonal* of a *rectangle, not* the hypotenuse of a right angled triangle. Though this difference seems trivial, it must be noted, since, to belittle Egypt, some scholars have gone to the absurd extreme of questioning whether Egyptians even knew of a right-angled triangle: (Gillings 1972; appendix 5) quotes from T. L Heath, “There seems to be no evidence that they [the Egyptians] knew that the triangle (3, 4, 5) is *right-angled*” (italics original). This wrongly assumes that the only way to state the “Pythagorean” proposition is by using a right-angled triangle. Egyptians certainly knew about rectangles, and their diagonals which divide the rectangle into two right angled triangles.

Secondly, all three ancient traditions made detailed *calculations* related to diagonals of rectangles. The

ability to make such calculations requires a distinctly *superior* understanding of the “Pythagorean” proposition *not* as a mere theorem but as the “Pythagorean” *calculation*. We need extra knowledge to be able

- (1) to *calculate* the diagonal (given the sides, which calculation requires knowledge of square roots), or
- (2) to *calculate* the sides, given the diagonal and one side, or the angle it makes with one side (as in navigation; this calculation requires knowledge of sine values).

Thus, if *a*, *b*, are the sides of the rectangle and *d* is the diagonal, the “Pythagorean” proposition is commonly stated today as $d^2 = a^2 + b^2$. However, for practical purposes we need to be able to use this to *calculate d*. Hence, in the Manava *sulba sutra* 10.10 (Sen & Bag 1983) (a manual for brick masons), the “Pythagorean” proposition is explicitly stated using square *roots* as $d = \sqrt{a^2 + b^2}$.

What difference does that make? It makes two key differences. First, using the second form above requires knowledge of a method of extracting square roots. Such a method of extracting square roots was certainly known to Ahmose, since problems involving square roots are found in the Berlin papyrus, problems 1 and 2 (Clagett 1999). (Oddly, Lumpkin (1997) mentions these very two problems in the context of the Egyptian knowledge of the “Pythagorean theorem”, but like earlier authors she wrongly dismisses the connection with square roots as incidental.)

An important such square root is $\sqrt{2}$ the diagonal of the unit square, using which the diagonal of any other square can be calculated. Square-root extraction was certainly also known in Iraqi tradition, and YBC 7289 explicitly draws a square with its two diagonals, and calculates the diagonal of the unit square to an accuracy of the 3rd sexagesimal place. In Indian tradition, the diagonal of the unit square was also calculated to high precision. An explicit algorithm for square-root extraction (essentially the

algorithm taught in schools today) was stated by the 5th c. Aryabhata (1976 [5th c.]; p. 36) .

But no such method of square root extraction was known to the West until this knowledge arrived via Arabs. Without knowledge of the arithmetic needed for square-root extraction, the West could not fully understand or do the “Pythagorean” calculation. This Western ignorance of square roots is stamped on the very term “surd” used until today to denote square roots, such as $\sqrt{2}$, which cannot be evaluated as fractions. The term “surd” is from the Latin *surdus* meaning deaf and this term is incomprehensible until we understand that the word square root was used interchangeably with the diagonal of a square. The word for “diagonal” in Sanskrit is *karna* (कर्ण), which is also the word for ear. Hence, “inexact diagonal” was mistranslated as “bad ear” or “deaf root”!

Apart from this hilarious sidelight, which exposes the Western ignorance of geometry, let us look at the second difference which is that $\sqrt{2}$ cannot be *exactly* written down as a fraction: the process of square root extraction never terminates or recurs. In the language of the *sulba sutra*, the value of $\sqrt{2}$ is *inexact*. Indeed, in the *sulba sutra*-s (e.g. Baudhayana *sulba sutra* 2.12, Sen and Bag, 1983) , the term inexact (सविशेष) is virtually used as a synonym for $\sqrt{2}$. [13] Despite the mountains of metaphysics used to define an “irrational” number today (contrary to naive beliefs, to define it one must first define formal real numbers), there is no exact knowledge of it in reality. It is still not possible today to write down $\sqrt{2}$ exactly in the *real* world. So, the diagonal formulation of the Pythagorean proposition drives another nail in the coffin of the myth that the Greeks had exact knowledge of the “Pythagorean theorem”, for such exact knowledge is impossible in the real world. On the contrary, the boastful claim of math as exact knowledge interferes with a practically useful approximate understanding of it as the “Pythagorean” calculation, which has come down to us from ancient times.

The same situation arises for the (plane) navigational problem of determining latitude and longitude.

Here the lines of latitude and longitude meet approximately at right angles (the earth is a geoid, not a perfect sphere), and one must calculate the sides of the rectangle, *a*, *b*. There are two ways to solve the problem. First, from a knowledge of *d* and one of the sides, say, *a*, one can calculate the other, by using $b = \sqrt{d^2 - a^2}$. The 7th c. Bhaskar 1 (*Mahabhaskariya* II.3-4, Bhaskar 1960[7th c.]; pp. 49-50) explains this as a method of calculating the longitude of city 2 if its distance *d* to city 1 is known and the latitudes of the two cities are known (or measured), and the longitude of the departure point, city 1, is known. However, this requires accurate knowledge of the radius and local circumference of the earth to convert latitude differences to distances. Moreover, in the next verse he declares this method as “coarse” or “gross” because of difficulties in measuring the distance (*Mahabhaskariya*, II-5; Bhaskar 1960[7th c.]; p. 50), difficulties which applied also to the crude European navigational method of “heaving the log”, and maintaining a log book. In the same verse, Bhaskar adds that this method is “coarse” also because it assumes that the triangles involved are plane triangles, neglecting the curvature of the earth.

Without knowing the earth's radius, it is still possible to calculate both *a* and *b* from a knowledge of the diagonal *d* (“departure”) plus a knowledge of the “course angle”, or the angle θ that the diagonal *d* makes with one of the sides, say *a*. Thus, $b = d \sin \theta$. But this method explicitly requires a knowledge of sine values. Like $\sqrt{2}$ calculating the sine function again requires an infinite series, which can almost always *not* be summed *exactly*, except in an imaginary metaphysical world. In the real world, we can sum it to whatever level of precision is practically required, and this inexact sum is good enough for ALL practical purposes, such as navigation, but we cannot meet the ideal articulated by Berkeley (1734) that “the minutest Errors are not to be neglected in Mathematics” (section IV).

Thus the claim that math is exact knowledge is deceptive, since for any practical application of that purported “exact” knowledge we are anyway forced to descend to level of the real world to which that

“exact” knowledge applies only approximately! Secondly, claims of exactness drive us into an intermediate imagined world which may have features *contrary* to the real world, so it may result in conclusions (“infallible truths”) *contrary* to the real world and commonsense.

That is, it may result in *false* knowledge when that math is applied to the real world. For example, consider the Banach-Tarski paradox of set theory that using only the axioms of set theory one can take a ball of gold, and cut it into a finite number of pieces which can be reassembled into two balls of gold identical to the first! Continuing this process we can get any number of balls of gold identical to the first! It is obviously better to work directly at the level of approximate real-world knowledge.

To summarize, the claim that the “Pythagorean” theorem must be credited to Greeks since it is “of course a formal mathematical theorem of Euclidean geometry” is a complex mesh of lies. There is no historical evidence for either Pythagoras, or Euclid (only much evidence against “Euclid”). There are no formal mathematical theorems in the *Elements*; indeed, formal mathematical theorems did not exist prior to the 20th c. Most importantly, there is no value to proving such theorems which lead only to knowledge of imaginary worlds (which have “rabbits with horns”) which may be invalid knowledge in the real world.

Instead of the “Pythagorean theorem” the superior way is to do the “Pythagorean” *calculation*, which involves subtle refinements known in Egypt, Iraq, and India, but unknown in the West until very late. It was the absence of this real knowledge of the “Pythagorean” calculation which led to the European navigational disasters, and the longitude problem, which was the subject also of British parliamentary legislation, ca. 1713 and declared partly solved only in 1762. Therefore, the claims about Pythagoras, Euclid etc., and their theorems must be rejected as dishonest. It must be admitted that Greek and European knowledge was actually *inferior* to that of others.

What preserved this mesh of lies for so long? That is the weaknesses of the Western academic system, a systemic weakness which enabled false history to be concocted in the first place. That weakness arose

because the system was designed to suit church purposes, for the church had a monopoly over Western academics until the 19th c. That church system was designed to preserve fragile church dogmas, many utterly contrary to commonsense, such as the literal belief in virgin birth, which could not be preserved in any other way. Hence, censorship was an integral part of the system, and was, in fact, used to preserve absurd beliefs for centuries. Today that system is being used in the context of racism, to preserve the false claims of racist history by censoring anything contrary. Because this system usually involves secretive processes (e.g. secretive refereeing), dissent is usually shot down in the dark, without anyone ever knowing. The censorship of my article was an exception where matters became public. This shooting down of ideas and thoughts bodes ill for blacks in South Africa since it is a calculated way to preserve awfully false racist history, used to justify racism, and preserve white dominance of academics to the detriment of black students. Globally, too, if black lives are to really matter, black thoughts must start mattering first, and not be allowed to be shot down.

Notes

1 Such "covert institutional racism" (Mazama 2015) has been substantiated in the US context as the motivation for home schooling by African Americans (Mazama & Lundy 2012, and Lundy & Mazama, 2014).

2 This was the only version of the primary source available to me. However, I view this as a doctored primary source. Thus, Kant actually advocated not blows, as this source states, but the use of a split bamboo cane instead of a whip so that the negro would suffer a great deal of agony (Neugebauer 1990; p. 264).

3 Short video: http://youtu.be/ozQRBNk2alg, full video: https://www.youtube.com/eCoLlle9ANA.

4 Draft at http://ckraju.net/papers/Eternity-and-infinity.pdf.

5 The original is found on a wall of the tomb of Djeserkaseneb at Luxor. This *practical* Egyptian geometry should not to be confounded with Egyptian *mystery* geometry, later wrongly attributed to "Euclid", and misinterpreted as concerning deductive proof (Raju 2012c).

6 Since no hyperlink to these old references could be located, and a hyperlink was essential, the original hyperlink pointed to Raju (2007) which cites these references.

7 "Conversations in the Sun", 22 clips, archived from the *Sun*, Malaysia at http://ckraju.net/blog/?p=61.

8 "Mathematics? No Problem", *New Strait Times*, 24 July 2011, pp. H1-H2. Archived at http://ckraju.net/press/2011/NST-24-July-2011-pH1-H2-reduced.pdf.

9 "FIRST interview with Prof. C. K. Raju", *Aseema*, Jan 2016. Archived at http://ckraju.net/press/2016/FIRST-interview-with-Prof-CKRaju-Published-in-Aseema2016.pdf.

10 http://ckraju.net/blog/?p=119.

11 Brahmagupta, ब्राह्मस्फुटसिद्धांत, chapter 11, तन्त्रपरीक्षाध्याय, verses 15-16. "भूव्यासस्याज्ञानाद् व्यर्थं देशान्तरं".

12 The subtle principle of harmonic interpolation used in this navigational instrument called the *kamal* or *rapalagai* was not comprehended by any earlier historian, including James Prinsep, who tried to belittle everything non-Western.

13 Hence, I reject Beatrice Lumpkin's concession that Egyptians and Iraqi's did not know this was a number different from fractions. Certainly, Indians did. And certainly India was connected to Egypt and Syria via sea trade since the days of Harappan ports, and long before Alexander. So, why shouldn't the other two have not known (on balance of probabilities)? It is, on the other hand, beyond belief that early Greeks could have known that, since they did not even know fractions! All sorts of anachronistic knowledge has been wildly attributed to ancient Greeks on faith-based history.

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