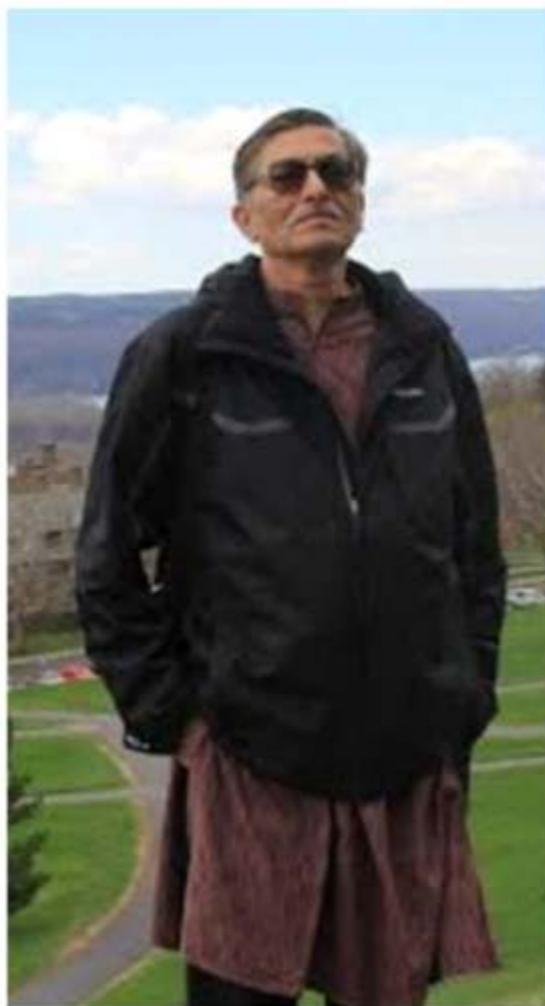


# "We need swaraj in education"

## Interview with Dr. Chandra Kant Raju

*Mathematics is perceived as abstract and profound. Across the globe, mathematics is taught widely, with similar syllabus and often compulsorily. Generally, mathematics is seen as an objective subject based on rational foundations, as a universally applicable stream of knowledge. Mathematics is credited for the remarkable progress of Science and Technology. Mathematicians cherish the beauty of formal mathematical methods and structures. In this interview with FIRST (Foundation for Indic Research Studies), eminent Mathematician and Physicist Prof. C.K.Raju shares some of his insights that provide a paradigm shift in our perspectives about science and mathematics.*



### What is wrong with formal mathematics?

Formal mathematics is about proving theorems from axioms. Axioms are not certain truths, and need have nothing to do with empirical reality, but are just a chosen set of postulates. Furthermore, formal mathematics prohibits any reference to the empirical world, and accepts only proofs based on two-valued logic. On Western myth two-valued logic is universal. However, that is not true. Hence, theorem proving becomes just a pointless ritual. Indeed, any proposition whatsoever, no matter how silly, can be proved as a mathematical theorem, for example the proposition that "God has two horns". The understanding that the theorems of mathematics are eternal or certain truths is a wrong perception. It is not "as certain as  $2+2=4$ ", as the late Daya Krishna once said.

### So, is it certain that $2+2=4$ ?

All of us understand  $2+2=4$ . Our understanding uses examples such as two apples and two apples to make four apples. Obviously, this is empirical: we are able to see the apples in question. However, formal mathematics disallows that empirical understanding, so  $2+2=4$  need not be true in formal mathematics. It could be anything, 0 or 1 or 5 or 6. Formally speaking, we must specify that the symbols 2, +, =, 4 all concern "integers". But what is an "integer"? In formal mathematics, an integer is specified using Peano's axioms or set theory. That brings in infinity and its Western metaphysics by the backdoor, even at so elementary a level. The easiest way to infinity into the formal understanding of  $2+2=4$  is to try to do integer arithmetic on a computer. A computer cannot handle infinity. It can manage  $2+2=4$ , but not 2 billion plus 2 billion as integers. (Try that in a Java program.) Nevertheless, calculations done on a computer are fine for practical applications, so that Western metaphysics of infinity has nil practical value. So why do we need it? Calling anything certain on the basis of that metaphysics of infinity (which most people don't understand) amounts to blind faith. Actually, it is faith in the related church doctrines of eternity which I totally reject. The empirical understanding, though fallible, is far more certain and universal.

**Formal mathematics is behind the success of modern science and technology. Why should we turn to empirical approach?**



"For nearly eight centuries, all Western scholars who studied the Elements made a foolish and persistent mistake and believed it to be a valid deductive proof"

Formalism came into existence only in the 20th c.: even the Elements attributed to Euclid uses empirical proofs in an essential way. So all applications of mathematics to science and technology before the 20th c. had nothing whatsoever to do with formal math. Even today, most physicists and engineers still learn calculus the old way. So formal math is certainly not the basis of modern science. On the contrary the success of science is based on rejecting metaphysics and accepting the empirical. So, if we do mathematics for science and technology, we should welcome the empirical approach.

### Has empirical approach contributed to Mathematics?

The Western perception is that deductive proof is superior to empirical proof. The deductive approach is projected by the West as infallible. But this is a myth. Look at the very first elementary proposition of the Elements. For nearly eight centuries, all Western scholars who studied the Elements wrongly believed it to be a valid deductive proof. Such a foolish and persistent mistake, as Westerners made with deductive proofs, is not likely with empirical proofs.

Indian philosophy accepts both deduction and empirical proofs, whether for mathematics or anything else. Empirical proofs were used in Indian mathematics (gaNita) for at least two thousand years. If the objective of mathematics is practical applications, as I think it is, those applications concern the empirical world, so there is certainly no reason to reject empirical proofs.

### Do you agree that Mathematics is objective and rational?

Objectivity does not attach to formal math, since the choice of axioms is subjective. In practice, the axioms are invariably those chosen by Western authority. Either way formal math has no claims to objectivity.



"Christian rational theology spread the myth of a universal rationality - rationality is NOT universal"

The concept of rationality is NOT universal. "Rationality" depends upon the choice of logic, which is not unique as Westerners thought. Christian rational theology, during the Crusades, spread the myth of a universal rationality, by claiming that logic bound their God who could not create an illogical world. They also argued that logic was "stronger" than facts since God, though bound by logic, could create any facts of his choice. In fact, however, we have an infinity of different logics to choose from. To make an objective choice we would have to decide logic on empirical grounds. That would be a requiem for formal mathematics, since if logic itself is "proved" using empirical grounds how can we continue to reject empirical proofs as "weaker"?

The term mathematics is derived from a Greek word meaning 'learning'. So, it applies to both empirical and deductive approaches...

You may find it interesting to know that there is a little-known third kind of mathematics. Plato was concerned with mathematics, which was neither practical, nor formal, but spiritual. Originating in Egypt as mystery geometry, this mathematics was concerned with 'mathesis' or learning. Plato said that "all learning is recollection". He thought, learning requires us to arouse the soul to make it recollect its eternal ideas from past lives. Proclus explains that is why "mathematics" derives from "mathesis", for it is the science of arousing the soul. Plato was referring to this spiritual mathematics when he deprecated the practical value of mathematics since he thought soul arousal was more important, since it led to virtue.

Plato thought mathematics involves eternal truths. Hence he regarded mathematics as especially suited to arouse the eternal soul. This was on the principle of sympathetic magic, that "like arouses like". It was on such grounds that the West wrongly held for centuries, that mathematics contains eternal truths. In fact, there are no such "eternal" truths in formal mathematics.

Reasoning was important for spiritual mathematics,

since the aim was to drive the mind inwards, and away from empirical reality: it was a sort of meditation, like yoga which requires us to close our eyes. That understanding of reasoning, related to soul arousal, should not be confounded with the church understanding of reason, as merely a means of persuading others, or a means of proof. Indeed, the Elements was a book on spiritual mystery geometry. However, the church wrongly reinterpreted it. To support its new theology of reason, the book was declared a book on the latter sort of reasoning, useful to persuade others—the job of the church. This reinterpretation was supported by a false myth that the book was written by an unknown Euclid whose intentions were easily fabricated. Hence, today, that spiritual mathematics is confounded with formal mathematics, though the main thing common to both is the assertion that the practical value of mathematics is unimportant.



"Mathematics is derived from 'mathesis'- the science of arousing the soul. Plato was concerned about 'spiritual mathematics' and not 'rational mathematics' or 'gaNita'"

Formal mathematics is appreciated for its beauty, elegance...

The confusion between spiritual and formal mathematics is propagated in another way: by appealing to the myth of beauty in mathematics. This is complete nonsense, like the emperor's new clothes: Thousands of disgruntled students attest to the ugliness of formal mathematics, which repels them. Plato advocated both math and music to be taught to young people of his Republic. But, today, while young people are still passionate about music, they hate math.

In other words, the transition from spiritual mathematics to formal mathematics destroyed the beauty in math. A few experts, with their vested interests, keep trying to pass off the ugliness of formal math as beauty. Actually, formal mathematicians are hard put to justify what they do. So they talk of intangibles like the beauty of the proof. This is nothing but a con trick. Formal mathematicians typically still compare their proofs to written compositions of Western music. Even if that is true, mathematics

should be treated as a cultural form, like Western music, and not be given funds from science departments. Formal mathematics should certainly not be taught as a compulsory subject any more than Western music should be so taught.

India is the cradle of mathematics. But formal mathematics is credited to West. How was mathematics transformed?

Yes, historically speaking, much practical mathematics (most school math: arithmetic, algebra, trigonometry, calculus, probability) originated in India for its practical applications, and was transmitted to the West for its practical applications. However, it had many puzzling features such as summing infinite series. Because of church dominance in the West, Indian gaNita was given a layer of metaphysics to make the notions of infinity compatible with church doctrines of eternity, and later turned into formal math. This coating of metaphysics did nothing to enhance the practical value of mathematics: to send a rocket to Mars we still numerically solve ordinary differential equations, as Aryabhata did, and most engineers never hear of Peano's existence theorem. So, formal math is not necessary for the applications to science. Colonial education emphasized the metaphysics of math just because factually that education was brought to us by the church with the key aim of indoctrination.



"Mathematics may be considered as a cultural form, like Western music, and not be given funds from science departments"

How do you say that Mathematics is copied?

Today, a false history of science is spread through school texts and Wikipedia. It asserts that science is a Western creation first done by early Greeks, and then in post-renaissance Europe. This false history has great power. For instance Macaulay used it to impose colonial education, which mentally enslaved vast populations and enriched the West. Therefore, we should cross check it. That false history sought to glorify one set of people ("Christians and friends", whites, West) and denigrate others. This was done by systematically claiming credit for work copied from others.

There are various ways to expose this copying, for example by using non-textual evidence. Greek and Roman arithmetic was primitive, so how could they have done any science? The point of my epistemic test is that those who copy do so with incomplete understanding. For example, when Europeans started replacing their primitive Roman arithmetic with sophisticated Indian algorithms they did not understand the kindergarten arithmetic of algorithms. Pope Sylvester, who first imported that arithmetic from Cordoba, thought that an abacus was essential to arithmetic. Hence, the terminology "Arabic numerals", as he thought efficiency of that arithmetic was due to some magic in the shape of the numerals! Likewise, Florentine merchants did not understand "zero". The word derives from the Arabic sifr or cypher meaning mysterious code. Europeans found zero mysterious because unlike Roman numerals, which are additive (XII means X + I + I), place value representations are not additive (120 does not mean 1+2+0).

Therefore, a correct history leads also to a better understanding. For example, George Joseph and Dennis Almeida have serially plagiarized my thesis that calculus was transmitted from India. However, they lack a solid background in mathematics and physics, and have no knowledge of Sanskrit, hence cannot read the primary sources of Indian gaNita, so they could not really understand other aspects of my thesis. To be politically correct, they just wildly claimed that the thesis of transmission of calculus does not affect Newton's greatness. Of course it does. More importantly, once we understand how Newton misunderstood calculus that leads us not only to a better calculus but also to a better theory of gravitation. Thus, an ethically correct understanding of calculus transmission also leads to a better understanding of calculus and physics.



"Pope Sylvester, who first imported that arithmetic from Cordoba thought efficiency of that arithmetic was due to some magic in the shape of the numerals! Likewise, Florentine merchants found "zero" mysterious - the word derives from the Arabic sifr or cypher meaning mysterious code"

# Nature of Mathematics

The common view of mathematics is that it extends human (and scientific) knowledge and solves real life problems, especially with the help of computation power that we have today.

However, schools and universities teach formal mathematics as part of core curricula. Formal mathematics is all about deducing theorems from some axioms (meaning postulates, not uncontested truths), using two valued logic. Any set of postulates may be chosen; postulates have no proof and need have no relation to reality. Two-valued logic categorizes propositions as either 'Truth' or 'False'. It is used to deduce theorems, from postulates.

Formal mathematics is thus based on two things – a set of axioms and a logic. Mathematical theorems are not universal or certain truths. They are not even truths relative to axioms as formal mathematicians even now wrongly assert. Mathematical theorems are at best

true relative to axioms AND relative to logic. While axioms are subjective, there are different logic systems too. We had two-valued logic in India (Naiyayikas used it). But we also had various other systems of logics from pre-Buddhist times, as well as the Buddhist *catuskoti* and Jain *syadavada*. In the West, two valued logic was closely connected to the Christian theology of reason adopted by the church during the Crusades.

However, the practical core of mathematics is related to calculations, as in everyday useful *gaNita*. Historically speaking, most of this core developed in India and was transmitted to Europe. Because Europeans had difficulties in understanding it, Indian *gaNita* was given a coating of Western philosophy, and a false history, and morphed into formal mathematics. Colonialism globalised this mathematics as superior. Thus, we have a situation today where practical *gaNita* is combined with formal mathematics driven by Western philosophy.

## So, there are appropriations and distortions in Mathematical world?

Yes. That is the basis of a whole bunch of Western myths which are swallowed by the colonially indoctrinated with their mother's milk. For example, Pythagoras and Euclid are mythical figures who never existed, but we are still discussing those myths. The wrongly called Pythagorean Theorem is falsely attributed to Pythagoras on the ground that he had a deductive proof of it. Others such as Egyptians and Indians are denigrated by saying they had only some practical knowledge of land-surveying, not real geometry. But what evidence do we have that a deductive proof of the "Pythagorean theorem" existed? If so, what was it? As already pointed out, there was no valid deductive proof of the theorem until the 20th c., not even in the *Elements* falsely attributed to an early Greek called Euclid. It is yet another myth that deductive proof was the intention of the anonymous 5th c. "author of the *Elements*" as she is called by Greek

commentators. Formal mathematics began with the false story of the purported intentions of the mythical Euclid. To save the wretched story, Russell and Hilbert distorted the actual book, *Elements*. Hilbert declared it a text on synthetic (non-metric) geometry. Hence, he replaced the term "equal" in the original book by the term "congruence". Our school texts foolishly imitate that: they teach congruence, and speak of the Side angle Side postulate, whereas it was a proposition in the original book. No educator or school teacher applied his or her mind to the fact that Hilbert's interpretation manifestly fails beyond the 34th proposition of the *Elements*. Since formal mathematics is divorced from the empirical world, it has social authority as its sole anchor. Since Hilbert was a dominant Western mathematician, they accept his authority. Society is not utopia, so social authority is often established through falsehoods, and appropriation.

**Is your objections to formal mathematics about its history and not purely scientific?**

Not really. As in the example of Newton, already given above, a bad understanding of calculus led to bad physics. Correcting that history leads to a better understanding and improves science. Formalism has not been particularly successful either with 20th c. science like quantum field theory. That could never be axiomatised despite Wightman, since both university calculus and its replacement, the Schwartz theory of distributions, fail in that context. Von Neuman's axiomatisation of quantum mechanics has generated endless controversy. (Formalism comes in through the use of Hilbert space, which differs from matrix mechanics by its notions of convergence, and in the projection postulate, he used to describe measurement.) In both the above contexts, as also in other contexts such as shock waves in general relativity, and Maxwellian electrodynamics, I have demonstrated the advantages for science of my approach to mathematics through zeroism and empirical inputs. This is too complicated to explain here.

"A whole bunch of Western myths which are swallowed by the colonially indoctrinated with their mother's milk"



Are you objecting to metaphysics behind formal mathematics?

Yes. In fact, the metaphysical coating of mathematics hindered science, much more than direct church interventions. For example, just because Westerners superstitiously believed mathematics contains eternal truths (a relic of spiritual mathematics) they thought math must be perfect, and cannot admit the minutest errors. Minute errors have no practical significance. However, Europeans struggled for centuries with the infinite series of the Indian calculus, trying to obtain the "perfect" sum of an infinite series without the minutest error! In this process, of trying to make calculus perfect, and have a "perfect" account of the time derivative, Newton made time metaphysical. His physics hence failed. Correcting it leads also to a better theory of gravity.

Then, why do present day academics pursue formal mathematics?

First, because colonialism globalised an education system which offers jobs only in formal mathematics.

As a formal mathematician responded to this question, "they are willing to pay for it." Second, because present-day academics are the products of colonial education which teaches subordination to Western authority even in science. Thus, even in the formal mathematics that Indians do, the unwritten rule is that we must use only those axioms laid down by Western authorities. Do you know of any departure from this rule? This is the invariable consequence of moving away from the empirical to a particular metaphysics—it is a ruse that leads to the imposition of authority. The pose of "superior" or "rigorous" metaphysics with formal math is just a con trick exactly like (and closely related to) the racist pose of superiority.

How is reception to your views from authorities of formal mathematics across the world?

Formal mathematicians are hostile for they stand to lose their jobs if mathematics is taught with a different philosophy. Their life work would become valueless. People would soon laugh at them the way we today laugh at theologians who wanted to decide how many angels fit on the head of a pin. They realize that their arguments are weak so they are afraid to argue publicly. They avoid discussing even the possibility of an alternative philosophy of mathematics, such as the philosophy with which *gaNita* developed in India. Further, the West will never accept an alternative philosophy from a non-Western source. They may accept an alternative technique from a non-Western source, if they fail to plagiarize it and claim it as their own. Western universities do not teach non-Western philosophy as philosophy but as cultural studies. In international conferences on math education, they insisted that I should be allowed to speak only in the ethno-mathematics section, and not in the "real" mathematics part! They insist that mathematically illiterate but Western referees have a right to decide everything in secret. This is goonda rule, which we must break for the sake of our children.

"The metaphysical coating of mathematics hindered science"



In 15 years, no one has been able to publicly offer any substantive argument against what I am saying. I spoke about this even in MIT, pointing out that they teach

calculus wrongly, but there is no response. Compared to formal mathematicians, even astrologers in India are more responsive while responding to critiques and challenges. Formal mathematicians KNOW that their arguments cannot be sustained. Hence, they are more anxious than astrologers to avoid public debate. But we must debate the matter publicly because the education of our children matters more than the vested interests of formal mathematicians.

The West recognizes practical value, and will always accept it, but only together with a twisted tale. For example, Michael Atiyah, the foremost formal mathematician with both a Fields medal and an Abel prize, repeatedly tried to grab credit for my work (on functional differential equations and quantum mechanics), even after he was explicitly informed about my book. But he gave the same ideas a socially more acceptable pitch by accusing Einstein only in an indirect way, not in his Einstein centenary lecture, but in his talk to the press about it.

**"Persistent skepticism of Western authority, and a trust in oneself are prerequisites for bettering the present system"**



What kind of mathematics you propose?

Indeed, mathematics in all non-Western cultures traditionally concerned useful calculation, not theorem proving. I agree with that view of mathematics. Useful calculations are welcome. For practical value, one needs calculation, not theorem proving. For example, stock market fluctuations may be described by stochastic differential equations driven by Levy motion. It is easy to set up a way to calculate solutions of such equations. But there is no formal proof that solutions of such equations (metaphysically) exist.

I advocate traditional practical mathematics over formal mathematics. I advocate empirical proofs and calculations. I advocate the use of my new philosophy called zeroism, similar to sunyavada. This enables us to handle infinity better than the church metaphysics of eternity. Zeroism, a realistic philosophy, is just an explicitly stated way to handle abstractions in natural language. For instance the common understanding of the number 2 is as an abstraction derived from seeing

two pairs of objects. In this process, we ignore the fact that no two objects, say two apples, are ever exactly alike. That is, we learn about numbers as children, not only empirically, but by neglecting as inconsequential or zeroing the differences which exist between any two real apples. This is context dependent.

**"Even astrologers in India are more responsive while responding to critiques and challenges than formal mathematicians. They are more anxious than astrologers to avoid public debate"**



What is the need to reformulate mathematics pedagogy? Is there anything else that needs to be changed in mathematics?

The need to reformulate math teaching is obvious. Formalism makes the simplest math extraordinarily difficult. Russell dedicated some 378 pages to prove  $1+1=2$  in his Principia. He celebrated this difficulty as the chief achievement of formal math! And, the simple fact is that millions of students find this math difficult; they hate it and abandon it. This is not their fault or the fault of their teachers as the often suppose. The problem is with the very subject of formal math. Formal real numbers are too difficult to teach in school as NCERT admits. Few physicists and engineers ever learn about them.

Teaching formal mathematics often makes people incapable of applying mathematics to advanced practical problems. I found this out to my chagrin when in C-DAC I tried to hire formal mathematicians to implement problem level parallelization strategies, to port problems of economic importance (space, oil, etc.) on the target machine. Despite offering high salaries, I could not find suitable people.

Educating children into formal mathematics (the "new math" of the 1970's) added nothing to practical value, but does implant cultural and religious biases. For example, glorifying deductive proof over empirical proofs goes against ALL systems of Indian philosophy which are all agreed on empirical proofs (pratyaksapramana) as the first means of proof. Teaching the fallibility of empirical proofs also goes against Islam (which accepts tajurba), and against science which accepts experiment. The only thing it

suits is Christian rational theology and its beliefs about the relation of God to logic.

How is this translated? For example to high school math?

The compass box, used to teach geometry in schools, is deficient for it cannot be used to measure curved lines. However, even the most basic notion of geometry, an angle, cannot be defined without reference to curved lines. Consequently, I have found that most students are conceptually confused about the notion of angle, thinking it is about two straight lines as NCERT texts wrongly define it. Angles are measured by a protractor, but no explanation is ever given of how a protractor is constructed, or how a right angle is divided into degrees. Does the angle measured by a protractor depend on the size of the protractor, as I wondered in primary school? It requires the property of the circle, a curved line, to understand why it does not. The Indian 'sulba sutra' uses a string/rope which can entirely replace the compass box. It can also be used to measure curved lines. It is cheaper and eco-friendly.

This is just one example. Teaching calculus in this way makes it so easy that high-school students can easily solve even problems of "advanced" mathematics, such as Jacobian elliptic functions. I have demonstrated this with my own children, and with 8 groups in 5 universities in 3 countries.

**The compass box, used to teach geometry in schools, is deficient for it cannot be used to measure curved lines. The Indian 'sulba sutra' uses a string which can entirely replace the compass box"**



What needs to be done now/today? How? And who should do it?

That is a very good question.

First, we need swaraj in education. We need to take control of the education of our children. We need to teach superior gaNita to our students and not inferior formal mathematics.

Second, mathematics is taught as a compulsory subject in school. Any such compulsory subject must be secular, as per our constitution. We need to secularize

mathematics and science that is taught to our children, and not allow it to be penetrated by church theology, just because of some wrong belief that anything Western is secular.

Someone must sensitize the present government. There is a need to critically review colonial education in a serious way. That is essential to break the process of indoctrination which breeds a colonized mind set.

**"We need to take control of the education of our children. We need to teach superior gaNita to our students and not inferior formal mathematics. We need swaraj in education"**



These are some things that can immediately be done. (1) Critically review colonial education even in the hard sciences. (2) Organize public debates to precede or follow-up any such critical reviews. (3) Strongly oppose the religious biases and metaphysical baggage in present-day formal mathematics taught as a compulsory subject in school. (4) Expose the utterly false history of science on which the present philosophy of math is based.

We should be vocal in demanding action by government and increase awareness among people. The government should initiate the process of critical review and follow up with changes in our education system.

You have unique insights about science and mathematics. What are the prerequisites for another person to support these insights? And take them forward? What training are required for that person?

I believe any interested person can pitch in. I have written many books at a popular level. So, the issues can be broadly understood by anyone who puts in a little effort. The only prerequisite is a determination for swaraj. No special training is required, except persistent skepticism of Western authority, and a trust in oneself. – Concluded.