Annexure 8. Excerpts from the section on "Transmission of the Transmission Thesis" from C. K. Raju, *Cultural Foundations of Mathematics*, Pearson Longman, April 2007, demonstrating silly mistakes by Almeida 2001 which persists in the Manchester 2007 paper.

present the paper in Trivandrum. Almeida, being in the School of Education, felt that this invitation for a plenary talk in an international conference, that too in a session related to technology and education, would greatly add to the credibility of these ideas with his colleagues, and was very particular that I should send him a copy of the paper,[67] when I last met him in Goa in Dec 1999. (This Hawai'i paper is the other key paper not cited by the trio.) At that time, Almeida also formally agreed to be co-author of a chapter in this book, originally conceived as a series of essays by different authors. Later he asked for the revised copy of the paper in connection with a bid for funds from the Leverhulme trust, a bid in which G. G. Joseph, then a Reader in Economics at the University of Manchester, was invited to join, on the grounds that a British citizen was required to obtain this funding, and he also had some popular writings on the history of mathematics. At this stage the collaboration was terminated, due to disagreements, and I pointed out that it would be unethical for others to continue pursuing these ideas without my participation.

Finally, my Bangalore talk on the transmission of the calculus,[68] in Dec 2000, happened to be in a session chaired by G. G. Joseph, who naturally had a copy of the detailed abstract, and was at that time giving the School of Education of the University of Exeter as one of his affiliations, and was obviously associated with at least one member of the trio, though he, himself, was not a signatory to the trio's paper submitted subsequently on 22 February 2001—it is not necessary to go here into what transpired in Bangalore.

It would not be appropriate to discuss motivation etc. in the context of this book, although I have discussed it elsewhere, for instance in my formal complaint to the University of Exeter.

Finally, there is the principle of epistemological discontinuity which can be very well illustrated in the context. The principle is very simple. Those who copy without acknowledgement, also very often copy without adequate understanding. Therefore, lack of understanding is a good indication of lack of originality.

This lack of understanding is barely illustrated here using a couple of the more obvious howlers in the trio's paper.

The authors state[69] (p. 87)

> latitude was determined in the northern hemisphere by **measuring** the polar star **declination** (the angle of the pole star)—latitude was approximately equal to the altitude of the pole star. [Emphasis added]

As the deliciously vague phrase "angle of the pole star" suggests, there is a confusion here between the two angles: DECLINATION and ALTITUDE. The meaning of the sentence is quite unambiguous: the authors intend that the declination of the pole star is to be measured, and the altitude is presumably to be calculated!

This, of course, defeats a key aspect of the novel[70] thesis that was advanced above: namely that Jesuits searched for calendrical manuals in India because Europe then needed a good calendar for navigation. Why was a good calendar needed for navigation? According to my novel thesis, a good calendar was needed just because there was no easy way to measure declination at sea, but the (solar) declination could be easily estimated using a calendar, provided the calendar correctly fixed the day of the equinox. So if declination could have been *measured* so easily and directly at sea in the 16th c. CE, there would hardly have been any European need for a good calendar!

That this is no typo, but involves a conceptual confusion, is clear in the next howler, when the trio subsequently speak of

> **measuring** the solar **declination** at noon and then looking up tables correlated with the calendar. [Emphasis added]

Since, according to the repeated claim made by the authors, the solar declination could be directly measured at sea, and since it is the case that altitude could easily be observed with a simple instrument like a cross-staff (or *kamāl*), latitude could be readily calculated, using the *Laghu Bhāskarīya* formula. So what on earth was a "table correlated with the calendar" needed for? To help the navigator determine the date, perhaps!

That this is no typo, but a conceptual confusion, is proved beyond all reasonable doubt, when the authors repeat the same thing a third time, on the next page:

> **observations** of solar **declination** or pole star.... [Emphasis added]

It was, I believe, an established principle in Europe since the 17th c. CE to "booby trap" a mathematical table by deliberately injecting errors in it, just as some computer programmers (like me) have been known to booby trap source code (when compelled to disclose it against their wishes to persons whose credentials are not established) by deliberately injecting bugs in it. The source of these errors can be found in the first part of the Trivandrum paper NOT cited by the trio, which makes the same mistake, on p. 6:

> The widely distributed *Laghu Bhaskariya* (abridged works of Bhāskara) and *Maha Bhaskariya* (extensive works of Bhaskara) of the first Bhaskara (629 CE) explicitly detailed methods of determining the local latitude and longitude, using **observations** of solar **declination** or pole star, and simple instruments like the gnomon, and the clepsydra. Since local latitude could easily be determined from solar **declination** by day and e.g. pole star altitude at night (using an instrument like the kamal) an accurate sine table was just what was required.... [Emphasis added]

Since the objective here is only to illustrate the principles of evidence used to establish transmission, we take up just one more example to demonstrate the consequences of conceptual confusion regarding key aspects of the transmission thesis closely related to my other key (Hawai'i) paper that is also not cited by the trio. This involves a somewhat subtler point.

In the abstract of that paper, "Computers, mathematics education, and the alternative epistemology of the calculus in the Yuktibhāṣa", presented before a large number of scholars at Hawai'i, I had argued as follows:

> Current (formal) mathematics, being socially constructed, may change with technology.. . . Computers also use a different notion of 'number': unlike Turing machines, computers necessarily use floating point numbers, fundamentally different from real numbers on which mathematical analysis is currently based. An alternative pedagogy and epistemology of the calculus, bypassing real numbers is thus needed. A suitable alternative epistemology is found in the c. 1530 CE YuktiBhasa of Jyeshthadeva. . . Given the practical uses of computer simulation and the consequent social pressure to teach a changed notion of 'number' can the incompatible epistemologies of mathematics be reconciled?

Or even more succinctly, as stated in the four-line abstract of the paper for the table of contents of *Philosophy East and West*:

> Current formal mathematics, being divorced from the empirical, is entirely a social construct. . . Computer technology, by enhancing the ability to calculate, has put pressure on this social construct. . . .

The paper pointed out the representation of real numbers involves a supertask not necessary for practical purposes.

> For practical purposes, no supertask is necessary; the representation of numbers on a computer is satisfactory for mathematics-as-calculation, but it is unsatisfactory or "approximate" or "erroneous" from the standpoint of mathematics-as-proof. Indian mathematics, which dealt with "real numbers" from the very beginning ($\sqrt{2}$ finds a place in the *śulba sūtras*), does not represent numbers by assuming that such supertasks can be performed, any more than it represents a line as lacking any breadth, for the goals of mathematics in the Indian tradition were practical not spiritual. The **Indian** tradition of mathematics worked with a finite set of numbers, **similar** to the numbers available on a computer, and similarly adequate for practical purposes. Excessively large numbers, like an excessively large number of decimal places after the decimal point, were of little practical interest. Exactly what constitutes "excessively large" is naturally to be decided by the practical problem at hand so that no universal or uniform rule is appropriate for it. [p. 340, emphasis added][71]

The trio seize without acknowledgement this thesis that I had presented a year earlier in Hawai'i:

> we believe that mathematics is a social construct that alters with changing technology and that the current revolution in information technology will induce changes in mathematics.... (p. 96)

How is this to be linked to Indian mathematics? They take off:

> we re-iterate that floating point numbers were used by the Kerala mathematicians.... (p. 96)

Note that the thesis has been slightly changed: the term *similar* has been dropped, changing the thesis from analogy to identity, and the term *Indian mathematics* has been replaced by "Kerala mathematicians". Note also how these slight changes have oversimplified the thesis, laying it open to all sorts of doubts. (Where did Kerala mathematicians use the concepts of non-normal numbers and gradual underflow that one associates with floating point numbers?[72] Why only mathematicians confined to Kerala? Did they use numbers in a way different from other Indian mathematicians? What are the sources for this belief about use of numbers? etc.)

Through this oversimplification, the trio betray their lack of acquaintance with the philosophy of number underlying Indian mathematics. The problem with this is, as Nāgārjuna remarks, a half-understood concept of *śūnya* can be as fatal as a snake grasped wrongly—even slightly wrongly. This lack of understanding proves fatal to the trio's thesis as follows. Not quite understanding the Indian philosophy underlying the use of number, the trio of authors revert to a seemingly safe and conventional Western position (p. 96):

> We accept that mathematical analysis is based on the complete real number system needed for the existence of limits and that limiting processes can never be accomplished [sic] by a computer which uses a floating point number system.

However, this sudden reversion introduces a clash of epistemologies which stalls the original thesis in mid air, resulting in the inevitable crash. For, what after all is the use of Indian mathematics in the context? The trio continues

> we believe that a study of Keralese calculus will provide insights into computer-assisted teaching strategies for introducing concepts in *mathematical analysis*.... [p. 96, emphasis mine]

But how on earth can floating point numbers be used to motivate or teach formal real numbers? That amounts to putting the cart before the horse! And even supposing that floating point numbers (and concepts like non-normal numbers) can somehow be used to motivate formal real numbers, why not simply use computers for this purpose? Thus, it seems quite obvious to me that the task of computer-aided mathematics teaching can be performed perfectly well by software like my CALCODE (Calculator for Ordinary Differential Equations, which was purchased by the University of Exeter), especially since the ultimate object is to teach *mathematical analysis*! So, why bring in "Kerala mathematics" at all? Of course, the easiest way to understand the origin of these insoluble problems is to suppose that these problems have arisen from the oversimplification of a complex thesis, used without acknowledgement.[73]

The more important point here is to observe how the attempt to bring a novel thesis into a conventional epistemic fold so quickly makes it meaningless. This is exactly what happened also in the case of the calculus when it came to Europe with an epistemology of mathematics and number, that was incompatible with the European perspective into which it was forced to fit.