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Computers, Mathematics Education, and the Alternative Epistemology of the Calculus in the Yuktibhāṣā

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## **Abstract**

Current formal mathematics, being divorced from the empirical, is entirely a social construct, so that mathematical theorems are no more secure than the cultural belief in two-valued logic, incorrectly regarded as universal. Computer technology, by enhancing the ability to calculate, has put pressure on this social construct, since proof-oriented formal mathematics is awkward for computation, while computational mathematics is regarded as epistemologically insecure. Historically, a similar epistemological fissure between computational/practical Indian mathematics and formal/spiritual Western mathematics persisted for centuries, during a dialogue of civilizations, when texts on "algorismus" and "infinitesimal" calculus were imported into Europe, enhancing the ability to calculate. It is argued here that this epistemological tension should be resolved by accepting mathematics as empirically based and fallible, and by revising accordingly the mathematics syllabus outlined by Plato.

# COMPUTERS, MATHEMATICS EDUCATION, AND THE ALTERNATIVE EPISTEMOLOGY OF THE CALCULUS IN THE *YUKTIBHĀṢĀ*

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## *Introduction*

### *The East-West Civilizational Clash in Mathematics: Pramāṇa versus Proof*

In Samuel P. Huntington's terminology of a clash of civilizations, one might analyze the basis of the East-West civilizational clash as follows: the Platonic tradition is central to the West, even if we do not go to the extreme of Alfred North Whitehead's remark characterizing all Western philosophy as no more than a series of footnotes to Plato. But the same Platonic tradition is completely irrelevant to the East.

In the present context of mathematics, the key issue concerns Plato's dislike of the empirical, so the civilizational clash is captured by the following central question: *can a mathematical proof have an empirical component?*

### *The Platonic and Neoplatonic Rejection of the Empirical*

According to university mathematics, as currently taught, the answer to the question above is no. Present-day university mathematics has been enormously influenced by (David Hilbert's analysis of) "Euclid's" *Elements*. Proclus,<sup>1</sup> a Neoplatonist and the first actual source of the *Elements*, argued that

Mathematics . . . occupies the middle ground between the partless realities . . . and divisible things. The unchangeable, stable and incontrovertible character of [mathematical] propositions shows that it [mathematics] is superior to the kinds of things that move about in matter. . . . Plato assigned different types of knowing to . . . the . . . grades of reality. To indivisible realities he assigned intellect, which discerns what is intelligible with simplicity and immediacy, and . . . is superior to all other forms of knowledge. To divisible things, in the lowest level of nature, that is, to all objects of sense-perception, he assigned opinion, which lays hold of truth obscurely, whereas to intermediates, such as the forms studied by mathematics, which fall short of indivisible but are superior to divisible nature, he assigned understanding.

In Plato's simile of the cave, the Neoplatonists placed the mathematical world midway between the empirical world of shadows and the real world of the objects that cast the shadows. Mathematical forms, then, were like the images of these objects in water—superior to the empirical world of shadows but inferior to the ideal world of the intellect, which could perceive the objects themselves.

Proclus explains that the term "mathematics" means, by derivation, the science