Dialogue on the Fundamentals Of Sound Education Policy

by Lyndon H. LaRouche, Jr.

Democratic Presidential pre-candidate LaRouche, Jr. responds to a question on "education reform," sent to his campaign website.

Sometimes, even often, perhaps, the best way to attack an apparently nebulous subject-matter, such as today's animal-training of students to appear to pass standardized designs of tests, is to flank the apparent issue, in order to get to the deeper, underlying issues which the apparent subject-matter merely symptomizes. I respond accordingly.

There is a growing number of persons, chiefly university students, who have become active in our work here, and who represent special educational needs and concerns. These concerns include the insult of being subjected to virtually information-packed, but knowledge-free, and very high-priced education. More significant, is being deprived of access to the kind of knowledge to which they ought to have access as a matter of right. In various sessions in which they have tackled me in concentrations of one to several score individuals each, many of the topics posed add up to a challenge to me: "What are you going to do to give us a real education?" There is nothing unjust in that demand; I welcome it. However, delivering the product in a relatively short time, is a bit of a challenge.

I have supplied some extensive answers to that sort of question, but let me reply to your question by focussing upon what I have chosen as the cutting-edge of the package I have presented.

In the same period he was completing his ***Disquisitiones Arithmeticae,*** young Carl Gauss presented the first of his several presentations of his discovery of the fundamental theorem of algebra. In the first of these he detailed the fact that his discovery of the definition and deeper meaning of the complex domain provided a comprehensive refutation of the anti-Leibniz doctrine of "imaginary numbers" which had been circulated by Euler and Lagrange. Gauss, working from the standpoint of the most creative of his Göttingen professors, Kästner, successfully attacked the problem of showing the folly of Euler's and Lagrange's work, and gave us both the modern notion of the complex domain, as well as laying the basis for the integration of the contributions of both Gauss and Dirichlet under the umbrella of Riemann's original development of a true anti-Euclidean (rather than merely non-Euclidean) geometry.

In his later writings on the subject of the fundamental theorem, Gauss was usually far more cautious about attacking the reductionist school of Euler, Lagrange, and Cauchy, until near the end of his life, when he elected to make reference to his youthful discoveries of anti-Euclidean geometry. Therefore, it is indispensable to read his later writings on the subject of the fundamental theorem in light of the first. From that point of view, the consistency of his underlying argument in all cases, is clear, and also the connection which Riemann cites in his own habilitation dissertation is also clarified.

The Central Issue of Method

Now, on background. Over the past decades of arguing, teaching, and writing on the subject of scientific method, I have struggled to devise the optimal pedagogy for providing students and others with a more concise set of cognitive exercises by means of which they might come to grips with the central issue of method more quickly. I have included the work of Plato and his followers in his Academy, through Eratosthenes, and moderns such as Brunelleschi, Cusa, Pacioli, Leonardo, Kepler, Fermat, Huyghens, Bernoulli, and Leibniz, among others of that same anti-reductionist current in science. All that I can see in retrospect as sound pedagogy, but not yet adequate for the needs of the broad range of specialist interest of the young people to whom I have referred. I needed something still more concise, which would establish the crucial working-point at issue in the most efficient way, an approach which would meet the needs of such a wide range of students and the like. My recent decision, developed in concert with a team of my collaborators on this specific matter, has been to pivot an approach to a general policy for secondary and university undergraduate education in physical science, on the case of Gauss's first presentation of his fundamental theorem.

Göttingen's Leipzig-rooted Abraham Kästner, was a universal genius, the leading defender of the work of Leibniz and J.S. Bach, and a key figure in that all-sided development of the German Classic typified by Kästner's own Lessing, Lessing's collaborator against Euler et al., Moses Mendelssohn, and such followers of theirs as Goethe, Schiller, and of Wolfgang

Mozart, Beethoven, Schubert, the Humboldt brothers, and Gerhard Scharnhorst. On account of his genius, Kästner was defamed by the reductionist circles of Euler, Lagrange, Laplace, Cauchy, Poisson, et al., to such a degree that plainly fraudulent libels against him became almost an article of religious faith among reductionists even in his lifetime, down to modern scholars who pass on those frauds as eternal verities to the present time. Among the crucial contributions of Kästner to all subsequent physical science, was his originating the notion of an explicitly anti-Euclidean conception of mathematics to such followers as his student the young Carl Gauss. Gauss's first publication of his own discovery of the fundamental theorem of algebra, makes all of these connections and their presently continued leading relevance for science clear.

Platonic vs. Reductionist Traditions

This shift in my tactics has the following crucial features.

The crucial issue of science and science education in European civilization, from the time of Pythagoras and Plato, until the present, has been the division between the Platonic and reductionist traditions. The former as typified for modern science by Cusa's original definition of modern experimental principles, and such followers of Cusa as Pacioli, Leonardo, Gilbert, Kepler, Fermat, et al. The reductionists, typified by the Aristoteleans (such as Ptolemy, Copernicus, and Brahe), the empiricists (Sarpi, Galileo, et al., through Euler and Lagrange, and beyond), the "critical school" of neo-Aristotelean empiricists (Kant, Hegel), the positivists, and the existentialists. This division is otherwise expressed as the conflict between reductionism in the guise of the effort to derive physics from "ivory tower" mathematics, as opposed to the methods of (for example) Kepler, Leibniz, Gauss, and Riemann, to derive mathematics, as a tool of physical science, from experimental physics.

The pedagogical challenge which the students' demands presented to me and to such collaborators in this as Dr. Jonathan Tennenbaum and Mr. Bruce Director, has been to express these issues in the most concise, experimentally grounded way. All of Gauss's principal work points in the needed direction. The cornerstone of all Gauss's greatest contributions to physical science and mathematics is expressed by the science-historical issues embedded in Gauss's first presentation of his discovery of the fundamental theorem of algebra.

All reductionist methods in consistent mathematical practice depend upon the assumption of the existence of certain kinds of definitions, axioms, and postulates, which are taught as "self-evident," a claim chiefly premised on the assumption that they are derived from the essential nature of blind faith in sense-certainty itself. For as far back in the history of this matter as we know it today, the only coherent form of contrary method is that associated with the term "the method of hypothesis," as that method is best typified in the most general way by the collection of Plato's Socratic dialogues. The cases of the ***Meno,*** the ***Theatetus,*** and the ***Timaeus,*** most neatly typify those issues of method as they pertain immediately to matters of the relationship between mathematics and physical science. The setting forth of the principles of an experimental scientific method based upon that method of hypothesis, was introduced by Nicholas of Cusa, in a series of writings beginning with his ***De Docta Ignorantia.*** The modern Platonic current in physical science and mathematics, is derived axiomatically from the reading of Platonic method introduced by Cusa. The first successful attempt at a comprehensive mathematical physics based upon these principles of a method of physical science, is the work of Kepler.

From the beginning, as since the dialogues of Plato, scientific method has been premised upon the demonstration that the formalist interpretation of reality breaks down, fatally, when the use of that interpretation is confronted by certain empirically well-defined ontological paradoxes, as typified by the case of the original discovery of universal gravitation by Kepler, as reported in his 1609 ***The New Astronomy.*** The only true solution to such paradoxes occurs in the form of the generation of an hypothesis, an hypothesis of the quality which overturns some existing definitions, axioms, and postulates, and also introduces hypothetical new universal principles. The validation of such hypotheses, by appropriately exhaustive experimental methods, establishes such an hypothesis as what is to be recognized as either a universal physical principle, or the equivalent (as in the case of J.S. Bach's discovery and development of principles of composition of well-tempered counterpoint).

The Geometry of the Complex Domain

Gauss's devastating refutation of Euler's and Lagrange's misconception of "imaginary numbers," and the introduction of the notion of the physical efficiency of the geometry of the complex domain, is the foundation of all defensible conceptions in modern mathematical physics. Here lies the pivot of my proposed general use of this case of Gauss's refutation of Euler and Lagrange, as a cornerstone of a new curriculum for secondary and university undergraduate students.

Summarily, Gauss demonstrated not only that arithmetic is not competently derived axiomatically from the notion of the so-called counting numbers, but that the proof of the existence of the complex domain within the number-domain, showed two things of crucial importance for all scientific method thereafter. These complex variables are not merely powers, in the sense that quadratic and cubic functions define powers distinct from simple linearity. They represent a replacement for the linear notions of dimensionality, by a general notion of extended magnitudes of physical space-time, as Riemann generalized this from, chiefly, the standpoints of both Gauss and Dirichlet, in his habilitation dissertation.

The elementary character of that theorem of Gauss, so situated, destroys the ivory-tower axioms of Euler et al. in an elementary way, from inside arithmetic itself. It also provides a standard of reference for the use of the term "truth," as distinct from mere opinion, within mathematics and physical science, and also within the domain of social relations. Those goals are achieved only on the condition that the student works through Gauss's own cognitive experience, both in making the discovery and in refuting reductionism generically. It is the inner, cognitive sense of "I know," rather than "I have been taught to believe," which must become the clearly understood principle of a revived policy of a universalized Classical humanist education.

Once a dedicated student achieves the inner cognitive sense of "I know this," he, or she has gained a bench-mark against which to measure many other things.

Bringing the Invisible To the Surface

by Bruce Director

This is the second half of a pedagogical exercise on the great mathematician Carl Gauss' delving into the Fundamental Theorem of Algebra—something all high school graduates think they have learned. The first part, "The Fundamental Theorem: Gauss' Declaration of Independence," was published in EIR of April 12.

When Carl Friedrich Gauss in 1798 criticized the state of mathematics for its "shallowness," he spoke literally; and not only about his time, but also ours. Then, as now, it had become popular for academics to ignore, and even ridicule, any effort to search for universal physical principles, restricting the province of scientific inquiry to the seemingly more practical task, of describing only what's visible on the surface. Ironically, as Gauss demonstrated in his 1799 doctoral dissertation on the fundamental theorem of algebra, what's on the surface is revealed only if one knows what's underneath.

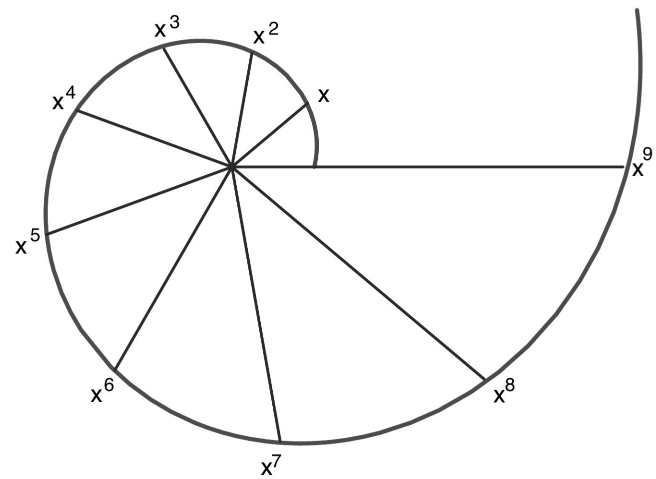
Gauss' method was ancient, made famous in Plato's metaphor of the cave, given new potency by Johannes Kepler's application of Nicholas of Cusa's method of On Learned Ignorance. For them, the task of the scientist was to bring into view, the underlying physical principles that could not be viewed directly—the unseen that guided the seen.

Take the case of Fermat's discovery of the principle, that refracted light follows the path of least time, instead of the path of least distance followed by reflected light. The principle of least distance is one that lies on the surface, and can be demonstrated in the visible domain. On the other hand, the principle of least time exists "behind," so to speak, the visible; brought into view only in the mind. On further reflection, it is clear, that the principle of least time was there all along, controlling, invisibly, the principle of least distance. In Plato's terms of reference, the principle of least time is of a "higher power" than the principle of least distance.

Fermat's discovery is a useful reference point for grasping Gauss' concept of the complex domain. As Gauss himself stated, unequivocally, the complex domain does not mean Euler's formal, superficial concept of "impossible" or imaginary numbers, as taught by "experts" since. Rather, Gauss' concept of the complex domain, like Fermat's principle of least time, brings to the surface, a principle that was there all along, but hidden from view.

As Gauss emphasized in his jubilee re-working of his 1799 dissertation, the concept of the complex domain is a "higher domain," independent of all a priori concepts of space. Yet, it is a domain, "in which one cannot move without the use of language borrowed from spatial images."

FIGURE 1



A succession of algebraic powers is generated by a self-similar spiral. For equal angles of rotation, the lengths of the corresponding radii are increased to the next power.

The Algebraic and the Transcendental

The issue for him, as for Gottfried Leibniz, was to find a general principle that characterized what had become known as "algebraic" magnitudes. These magnitudes, associated initially with the extension of lines, squares, and cubes, all fell under Plato's concept of dunamais, or powers.

Leibniz had shown, that while the domain of all "algebraic" magnitudes consisted of a succession of higher powers, this entire algebraic domain was itself dominated by a domain of a still higher power, which Leibniz called "transcendental." The relationship of the lower domain of algebraic magnitudes, to the higher non-algebraic domain of transcendental magnitudes, is reflected in what Jakob Bernoulli discovered about the equi-angular spiral (see Figure 1).

Leibniz, with Jakob's brother Johann Bernoulli, subsequently demonstrated that this higher, transcendental domain does not exist as a purely geometric principle, but originates from the physical action of a hanging chain, whose geometric