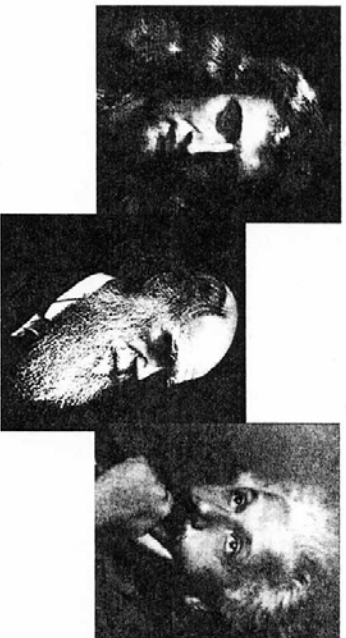


## The Questioning Mind in Science:

Newton, Darwin, and Einstein<sup>1</sup>



Most people think that genius is the primary determinant of intellectual achievement. Yet three of the most distinguished thinkers had in common, not inexplicable genius, but a questioning mind. Their intellectual skills and inquisitive drive embodied the essence of critical thinking. Through skilled deep and persistent questioning they redesigned our view of the physical world and the universe.

Consider Newton. Uninterested in the set curriculum at Cambridge, Newton at 19 drew up a list of questions under 45 heads. His title: "Quaestiones," signaled his goal: constantly to question the nature of matter, place, time, and motion. His style was to slog his way to knowledge. For example, he "bought Descartes's *Geometry* and read it by himself. When he got over two or three pages he could understand no farther, then he began again and advanced farther and continued so doing till he made himself master of the whole...."

When asked how he had discovered the law of universal gravitation, he said: "By thinking on it continually." I keep the subject constantly before me and wait till the first dawns open slowly, by little and little, into a full and clear light." This pattern of consistent, almost relentless questioning, led to depth of understanding and reconstruction of previous theories about the universe.

Newton actively recognized knowledge as a vast field to be discovered: "I don't know what I may seem to the world, but, as to myself, I seem to have been only like a boy playing on the sea shore, and diverting myself in now and then finding a smoother pebble or prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."

Darwin's experience and approach to learning were similar to Newton's. First, he found traditional instruction discouraging. "During my second year at Edinburgh I attended lectures on Geology and Zoology, but they were incredibly dull. The sole effect they produced in me was the determination

never as long as I lived to read a book on Geology, or in any way to study the science."

His experience at Cambridge was similar: "During the three years which I spent at Cambridge my time was wasted... The work was repugnant to me, chiefly from my not being able to see any meaning in [it]..."

Like Newton and Einstein, Darwin had a careful mind rather than a quick one:

"I have as much difficulty as ever in expressing myself clearly and concisely; and this difficulty has caused me a very great loss of time, but it has had the compensating advantage of forcing me to think long and intently about every sentence, and thus I have been led to see errors in reasoning and in my own observations or those of others."

In pursuing intellectual questions, Darwin relied upon perseverance and continual reflection, rather than memory and quick reflexes. "I have never been able to remember for more than a few days a single date or line of poetry." Instead, he had, "the patience to reflect or ponder for any number of years over any unexplained problem... At no time am I a quick thinker or writer: whatever I have done in science has solely been by long pondering, patience, and industry."

Einstein, for his part, did so poorly in school that when his father asked his son's headmaster what profession his son should adopt, the answer was simply, "It doesn't matter; he'll never make a success of anything." In high school, the regimentation "created in him a deep suspicion of authority. This feeling lasted all his life, without qualification."

Einstein commented that his schooling required "the obedience of a corpse." The effect of the regimented school was a clear-cut reaction by Einstein; he learned "to question and doubt." He concluded: "... youth is intentionally being deceived by the state through lies."

He showed no signs of being a genius, and as an adult denied that his mind was extraordinary: "I have no particular talent. I am merely extremely inquisitive." He failed his entrance examination to the Zurich Polytechnic. When he finally passed, "the examinations so constrained his mind that, when he had graduated, he did not want to think about scientific problems for a year." His final exam was so non-distinguished that afterward he was refused a post as an assistant (the lowest grade of postgraduate job).

Exam-taking, then, was not his forte. Questioning deeply and thinking critically was.

Einstein had the basic critical thinking ability to cut problems down to size: "one of his greatest intellectual gifts, in small matters as well as great, was to strip off the irrelevant frills from a problem."

When we consider the work of these three thinkers, Einstein, Darwin, and Newton, we find, not the unfathomable, genius mind. Rather we find thinkers who placed deep and fundamental questions at the heart of their work and pursued them passionately.

<sup>1</sup>Sources: *Einstein: The Life and Times* by Ronald Clark and *Einstein* by C.P. Snow; Darwin: *The Autobiography of Charles Darwin*; Newton: *The Life of Isaac Newton* by Richard Westfall