**6.5 A history of the terminology associated with potential difference**

We include the following as a typical example of what teachers may mistakenly consider to be a straightforward topic but which is in reality anything but.

If we as teachers fail to recognize this then what chance do the students have?

It is imperative that we peel away the various layers of meaning associated with each term in Physics. Along the way we are likely to identify many of the problems that the scientists themselves encountered and which are reflected in the students’ answers. By teasing out each of these incorrect interpretations we will hopefully help the student to acknowledge the inconsistencies in their own mental plan and in turn develop a deeper understanding of the concept:

*John Roche, of Linacre College, Oxford, opened the session after tea, speaking on the concept of voltage. He began by claiming that* almost every concept in electricity and electromagnetism is ambiguous, and the concept of voltage is one of the most incoherent*. Its evolution is difficult to follow.*

*Abbé Nollet, in the 18th century, distinguished quantity and degree of electrification. Others made similar distinctions between quantity and intensity or tension or pressure – what we would call voltage.*

*Roche showed how the term “voltage” had come to be used nowadays in three different ways; for electromotive force, potential difference and (absolute) potential.*

*Volta defined electrical tension as the endeavour of the electrical fluid to escape from a body.* Volta’s tension was more akin to a force, unlike the modern definition of electromotive force, which is a misnomer, being defined in terms of energy*.*

*Ohm carried Volta’s concept to closed circuits with the idea that voltage was proportional to the difference in tension between the ends of a conductor. For Ohm, it was the gradient of electrical tension that drove the current.*

*Poisson introduced an entirely different concept, of charge divided by distance to a point, which Green called the potential. This was an analytical device only, arising from an analogy with Laplace’s gravitational potential function.*

*Kirchhoff reconciled Volta’s tension with Poisson’s potential function through the concept of energy or* vis viva *introduced by Helmholtz. From Kirchhoff, current is driven by the electric field in a conductor and voltage is related to the energy supplied, but physicists and electrical engineers do not usually think of them in this way.*

All the earlier interpretations remain current*, but with different weights, and* most of the time *voltage is seen as a driving energy.*

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What happens when we don’t take the time to tease out the difficulties students have with many of these abstract concepts? Perhaps we should consider the following:

*I know nothing more terrible than the poor creatures who have learned too much . . . What they have acquired is a spider’s web of thoughts too weak to furnish sure supports, but complicated enough to produce confusion.*

Ernst Mach