Edward Lee Thorndike and John Dewey on the Science of Education

STEPHEN TOMLINSON

ABSTRACT *At the beginning of this century the two most important theorists in the history of American education, Edward Thorndike and John Dewey, formulated radically different visions of how the art of teaching could be transformed into a science. Thorndike, combining a strongly hereditarian behavioural psychology with the newly developed techniques of statistical analysis, showed how schooling could be structured around the methods of industrial management. By atomising and standardising every aspect of the educational process, a cadre of experts and administrators would replace traditional rule-of-thumb methods with scientifically proven practices dovetailed to the needs of a modern state. Although Dewey was also committed to the value of science as a universal tool for human betterment, he completely rejected the epistemological, psychological and sociological assumptions implicit in Thorndike's technocratic vision. In contrast to Thorndike's mechanistic world view, Dewey formulated an organismic ontology modelled on the process of adaptation and demonstrated that the scientific method depends upon the construction of a democratic community of problem solvers. By evaluating these theories of human nature and the social good, I discuss the failings of Thorndike's programme within the American school and explain the implications of Dewey's more sophisticated arguments for educational practice.*

According to Francis Bacon, the discourses of the philosophers were like the stars, so high up they shed little light [1]. The target of Bacon's criticism was scholasticism and its fusion of Aristotelian science and Christian doctrine into a fixed religious text from which the nature and *purpose* of all events could be deduced [2]. Assuming the truth of Aristotle's insights, the scholastics had turned science into a *theoretical* play of words, a spider's web of deductions, beautiful in their complexity, but so removed from reality they had little or no practical value. Moreover, by linking experimentation with dissent, the scholastics had undermined the free inquiry necessary to fuel social progress. In an era of commerce and discovery, Bacon recognised that 'knowledge was power,' an instrument through which nature could be manipulated to advance human well-being. Separating theology (and *teleology*) from natural philosophy, Bacon envisioned the establishment of a research institute, a laboratory of learning where, through open and cooperative inquiry, scientists could develop the technology necessary to advance medicine, agriculture, manufacturing and numerous other arts. As John Dewey recognised, although these plans were not realised during Bacon's lifetime, this synthesis of

0305-4985/97/030365-19

reason, freedom and progress made Bacon 'the great forerunner of the spirit of modern life ... the prophet of a pragmatic conception of knowledge' [3].

More than any other country, the America Dewey lived in had been transformed by the application of science to the problems of industry and society. But while welcoming the experimental attitude and material rewards of Bacon's utopia, Dewey was concerned that a new form of technocratic scholasticism had emerged: employing the deterministic concepts of the physical sciences, expert planners were developing social policies that reduced human beings to objects, inert atoms to be manipulated for external economic and political goals. Individuality and the quality of life were being sacrificed in the name of efficiency. As Bacon had undermined the Aristotelian division of *theoria* (the contemplation of eternal truths) and *techne* (productive skill), so Dewey attacked its modern counterpart, the dualism between theory and practice. Without its foundation in the stars, philosophy had to be reconstructed as an imminent critique of experience, a guide to how human beings could employ science to promote *both* the means and the ends of life. Dewey's pragmatism was thus conceived as a science of *praxis* (prudent conduct), an instrument for constructing and evaluating action in open-ended situations. Further, in contrast to both Aristotle and modern technocrats, Dewey rejected the authoritarian and elitist social hierarchy imposed by the division of thinking and doing: the values implicit in science demanded the construction of a democratic community of problem solvers. Nowhere did Dewey promote this message of *social* intelligence more urgently than in the debates surrounding the design of America's most important engineering project—the public school.

THE TECHNOLOGY OF SCHOOLING

As many authors have argued, much of current American school practice and the prevailing tradition of quantitative educational research is grounded in the psychological and organisational theories developed by social scientists of the Progressive Era [4]. In various fields, the founders of the twentieth century American school approached the myriad problems facing education in an emerging industrial, urban, and multicultural society with the newly developed tools of behavioural psychology, mental testing, and scientific management. Assuming that the methods of the natural sciences can be applied to the control of human behaviour, they established educational research as an applied science capable of yielding the value-free instruments and practices necessary for manufacturing the future citizens of a modern efficiently ordered state. The familiar regime of behavioural objectives, drill, intelligence testing, achievement scales, tracking, and vocational training are the direct legacy of this mechanical model of mind and society.

While popular critics, historians, and philosophers have analysed and debated John Dewey's vision of progressive education, remarkably little attention has been paid to the thought and influence exerted by Edward Lee Thorndike, the leading theorist at Columbia University's Teachers College—America's most influential graduate school of education [5]. And yet, more than any other person, it was Thorndike who, from this institutional power base, shaped the curriculum, pedagogy, and organisational structure of the American school as well as the basic aims and methods of university-based inquiry. Indeed, broadly speaking, it is Thorndike's conception of human nature and the social good, rather than Dewey's, that permeates this century's mainstream literature and continues to generate what Henry Giroux has called 'a culture of positivism' within American educational thought and practice [6]. But, as critical theory and other

post-positivistic philosophies demonstrate, Thorndike's efforts to construct a science of education rest upon a number of unwarranted psychological and epistemological assumptions. By seeking to emulate the quantitative techniques of the natural sciences, he and his followers have frustrated a clear understanding of the complexity of the learning situation, systematically ignoring the creative, sentient, and culturally embedded character of human experience. And, by imposing a hierarchical division of labour between experts and practitioners, they have fostered an attitude towards scientific inquiry and the dissemination of knowledge that effectively reduces the teacher to a technician implementing research findings under the gaze of administrators and standardised measures of student performance.

Dewey was well aware of the dehumanising effect of such instrumental rationality and repeatedly warned against the drive to mechanise and manage all areas of life. People, he argued, cannot be treated as malleable components that may be fashioned for some fixed, externally determined social goal: they are themselves planners with the power and moral right to construct their own ends [7]. Even so, Dewey, no less than Thorndike, was passionately committed to science as a universal tool of human betterment, and believed that when applied to any domain, including education, it would bring haphazard and confusing events under intelligent control. The crucial difference was that where Thorndike saw educational science as a storehouse of objective knowledge produced by experts in laboratories and controlled research projects, Dewey viewed it as a method of rational problem-solving that could and should be employed by practitioners at all levels. Moreover, if, as Robert Crunden suggests, progressivism must be understood as a kind of 'displaced Protestantism', an effort to underwrite the modern state with traditional values, then Thorndike and Dewey presented two radically different social gospels [8]. Living amid the chaotic confluence of urban America and the intellectual riptide generated by the Darwinian revolution, both men embraced the 'new psychology' as the instrument for constructing a moral society. But where Thorndike developed a mechanistic ontology that stressed inherited powers and the need to conform behaviour to fixed standards of truth and goodness (a kind of secularised Calvinism in which social evil is constrained by the benevolent stewardship of the biologically elect), Dewey formulated an organismic conception of life, explained mind through the process of social adaptation, and defended a 'common faith' in the communal effort to face problematic situations.

Ellen Condliffe Lagemann has argued that 'one cannot understand the history of education in the United States during the 20th century unless one realises that Edward L. Thorndike won and John Dewey lost' [9]. Accordingly, to appreciate the structured context in which children are schooled, parents, educators, indeed society at large, must recognise how Thorndike's synthesis has developed into one of the most influential subtexts in educational thought and practice. We should realise that the school's theoretical architecture, like its physical structure, is an historical construct crafted with a particular set of intellectual tools in response to social, political and economic needs, and be alert to the fact that the common sense understandings this intellectual blueprint sustains are inherently problematic. By the same token, a careful reading of Dewey's more subtle and sophisticated arguments on the nature of knowledge, mind and schooling will help demonstrate the weaknesses in Thorndike's programme and encourage a more informed and critical approach to the solution of educational problems—an approach, I shall argue, that dovetails with and strengthens contemporary views of educational theory and practice developed in the wake of Jürgen Habermas's influential critique of the social sciences [10].

EDWARD LEE THORNDIKE

The New Psychology

According to E. G. Boring, 'American psychology inherited its physical body from German experimentalism, but got its mind from Darwin' [11]. In addition to identifying its 'heredity', Boring might have expanded on the role of nurture and the distinctive climate that promoted the rise of the social sciences in the USA. For, if it is possible to trace the origin of American psychology's scientific methodology to the training that men such as G. Stanley Hall, William James, and James Mckeen Cattell received in Wilhelm Wundt's laboratory at Leipzig, and its genetic theory of mind to British evolutionary associationism, then it was the practical goals of America's newly founded research universities which contributed the environment in which psychology would develop as an instrument of social control [12]. In particular, it was by combining methods of measurement styled on Wundt's 'psycho-physics' with the belief that human beings share an underlying homogeneous nature that the majority of American psychologists learned to construct their discipline as the categorisation and manipulation of group characteristics necessary for the bureaucratic management of large populations.

As Hall recognised, combining the genetic approach to human nature with the positivist philosophy of German experimentalism provided an axis of theory and method that would assure psychology's professional and academic acceptance. Eager to demonstrate the practical application of this union for education, Hall coordinated a two-pronged investigation into the natural development of the child [13]. A central focus of these studies was to differentiate instinctual from learned behaviours. But the first inquiry, a series of questionnaires designed to reveal the content of children's minds, was roundly criticised by Hall's peers as unscientific and anecdotal; the second, Franz Boas's now famous anthropomorphic examination of local boys and girls (in which he undermined the fixity of the Cephalitic index), created such a political storm that a moratorium was called on further child study within the Boston area [14]. This incident was to prove pivotal for Thorndike, who, as a doctoral student in psychology at Harvard, was directed away from an experimental study of children to the investigation of inherited and acquired behaviour in animals. Completed at Columbia under Cattell, Thorndike's description of the puzzle-solving abilities of cats and dogs, later elaborated and published as *Animal Intelligence*, became an immediate classic and an impetus for the future development of animal experimentation and learning theory [15]. Above all, by demonstrating how psychological laws could be combined with methods of quantitative analysis, Thorndike provided what Hall could not—a paradigm for the science of human engineering.

Education and the Manufacture of Virtue

As his biographer Geraldine Joncich Clifford acknowledges, there are few original ideas in Thorndike's writings. Indeed, the central concepts of his life's work were all learned during his undergraduate studies at Wesleyan University, where, guided by his first psychology teacher, Andrew C. Armstrong, Thorndike was introduced to his future discipline through James Sully's *Outline of Psychology* [16]. It was from this book, written from the perspective of British evolutionary associationism 'with special reference to the theory of education,' that Thorndike learned the practical value of genetic psychology for teachers and, as Clifford explains, the social importance of measuring

'individual difference, ... the narrow spread of training, and ... the "stamping-in" force of impressions in learning' [17]. Even Thorndike's dissertation—when viewed against the work of Herbert Spencer, George Romanes and Conway Lloyd Morgan—appears to be little more than a simplified reading of Spencer's philosophy of mind and a practical verification of Morgan's argument against Romanes that psychologists should avoid anthropomorphising the animal mind. Morgan had suggested that the apparently intelligent behaviour of animals can be explained without assuming the imitative and reasoning capacities of humans; acquired abilities, such as his own fox terrier's skill of opening the garden gate by lifting its latch, were simply the product of trial-and-error learning, a process commonly known as the 'Spencer-Bain' principle. In a number of similar tasks, Thorndike provided experimental confirmation of Morgan's argument by recording the diminishing times in which cats and dogs were able to free themselves by releasing the door catches of several home-made cages. The strong memory of his subjects, the smooth gradients of the resulting learning curves, and his own observations of their behaviour, convinced Thorndike that these animals did not reason the method of escape or imitate the actions of others, but, as Morgan had suggested, simply learned to associate correct actions with successful responses [18].

Combining this thesis of trial-and-error learning with a rather superficial reading of current ideas on neural anatomy, again derived from Spencer, Thorndike cemented his findings in what was to be the guiding metaphor of his life's work [19]. Following Karl Pearson, he argued that the brain, like the wires in a telephone exchange, was a complex of specialised neural bonds which predispose an organism to certain sensations, emotions or actions within a given situation [20]. Although many of these 'connections' between situation and response are determined by birth, new associations or habits could be 'stamped-in' according to just two principles of change: the Law of Exercise ('exercise strengthens the bond between situation and response') and the Law of Effect ('satisfying results strengthen, and discomfort weakens, the bond between situation and response') [21]. By the time he completed *Animal Intelligence* in 1911, Thorndike was convinced that his model could explain all aspects of learning, including the imitative and reasoning abilities of humans. 'Higher animals, including man,' he confidently asserted, 'manifest no behaviour beyond exception from the laws of instinct, exercise, and effect' [22]. The gentle inclines of his learning curves represented 'the wearing smooth of a path in the brain, not the decisions of a rational consciousness' [23]. 'Learning is connecting. The mind is man's connection system. Purposes are as mechanical in their nature as anything else.' [24].

Thorndike's thought and work have to be understood against the background of two institutional struggles: the drive to gain academic recognition for psychology within the American university, and the efforts at Teachers College to establish a corps of professionally trained educational administrators [25]. In Thorndike's mind, the first task depended upon demonstrating that psychology was a science, the second that this science could provide a foundation for educational practice. Both of these endeavors were implicitly tied to the basic project of positive philosophy: the employment of science and technology to ensure progress and the reconstruction of order eroded by the social, economic and intellectual upheavals of modern life. Meshing with the broad tide of American progressivism, Thorndike, like many social scientists of the day, was convinced that a meritocratic state free of waste, corruption and privilege could be achieved only when power was invested in men of superior intellect and virtue—a fusion of science, character and social planning that resonated with the psychometric studies and eugenic doctrines of Francis Galton [26].

In 1879 Galton had argued that 'until the phenomena of any branch of knowledge have been submitted to measurement and number, it cannot assume the status and dignity of a science' [27]. Five years later, Galton took psychology a step closer to this goal by opening an anthropomorphic laboratory at London's International Health Exhibition. For three pence he measured a person's mental faculties, reducing, as phrenologists had done, cognitive abilities to a numerical scale. Not only did this transaction provide participants with an objective record of their mental capacity—a valuable certificate in a growing market economy—it also helped Galton build a data bank of some 9,000 subjects from which to study the range of intelligence within the population [28]. By playing down the effect of the environment and sidestepping debates over the mechanism of genetic inheritance, Galton and his followers Karl Pearson and Charles Spearmann developed the basic tools of correlation and regression necessary to analyse the variance of socially important traits such as intelligence [29]. In so doing, they not only laid the foundation for modern statistical theory, but provided the basic instruments of testing and measurement that would weigh each person's value to a scientifically managed state. It was these reformist ideals that Thorndike sought to develop and popularise through his theoretical writings on research methods in education and his practical work on intelligence testing developed for the American army during the First World War and for the American school in the decades that followed.

Thorndike, who dedicated his first book, *The Human Nature Club*, to Galton, shared the view that science depends upon the quantification of phenomena [30]. He also accepted Galton's social philosophy. Throughout his writings, the assumption that 'human ability is largely determined by birth' acts as a theoretical premise from which he continuously draws the practical conclusion that 'progress depends on identifying and training each person for the social role to which they are most suited'. In fact, because Thorndike believed that intelligence and virtue varied directly with race and class, he fully embraced the negative as well as the positive doctrines of eugenics. As late as 1940, despite advances in anthropology (which demonstrated the pivotal role culture plays in shaping human nature) and in post-Mendelian genetics (which illustrated the complexity of the genotype) that had effectively undermined the theoretical pillars of eugenics—notably the work of Franz Boas and T. H. Morgan, as well as faculty at Columbia—Thorndike was still prepared to argue that:

> By selective breeding supported by a suitable environment we can have a world in which all men will equal the top ten percent of present men. One sure service of the able and good is to beget and rear offspring. One sure service (about the only one) which the inferior and vicious can perform is to prevent their genes from survival [31].

Like Galton, Thorndike saw no bounds to the mathematisation of experience. 'Whatever exists', he claimed, 'exists in some amount.' [32]. Echoing the themes of Spencer's famous essay, 'What knowledge is of most worth', Thorndike maintained that far from destroying the qualitative, quantitative measurements yield a degree of exactness and control that enhance our appreciation of events [33]. Most importantly, to the objective eye, statistics provide the key to unravelling the complexities of social phenomena:

> Tables of correlations seem dull, dry, unimpressive things beside the insights of poets and proverb-makers—but only to those who miss their meaning. In the end they will contribute tenfold more to man's mastery of himself. History

> records no career, war or revolution that can compare in significance with the fact that the correlation between intellect and morality is approximately .3, a fact to which perhaps a fourth of the world's progress is due [34].

And yet, despite the sophistication of their statistical instruments, both Galton and Thorndike showed considerable naivety in the application of this crude positivism. Galton, for example, constructed a beauty map of England based upon the frequency of pretty women he observed during visits to different towns and cities, while Thorndike, obsessed with the fear of declining intelligence and morals, employed indexes of class and race to form a 'goodness' chart of the USA. Not afraid to put a value on life, Thorndike actually developed a calculus of human worth. In his last major work, *Human Nature and the Social Order*, he explained that if an ordinary person's desires count for 100 units, then a genius's should be worth 2,000, an idiot's 1, domestic animals 1/500, and other creatures 1/10,000 [35]. Son of a Methodist minister, Thorndike may have given up religion for psychology, but he never escaped the dismal world view of Calvin. If the elect were now chosen by biology rather than God, virtue and achievement still remained different sides of the same coin. Underwriting Thorndike's world view was his basic commitment to a Laplacian universe:

> No response of any human being occurs without some possibly discoverable cause; and no situation exists whose effect could not with sufficient knowledge be predicted. Things do not happen by mere chance in human life any more than in the fall of an apple or in an eclipse of the moon. The same situation acting on the same individual will produce, always and inevitably, the same response. If on different occasions it seems to produce different responses, it is because the individual has changed in the meantime and is not the same creature that he was. At the bottom of the endless variety of human nature and circumstance there are laws which act invariably and make possible the control of human education by reason. So the general rule of reason applies to education: *To produce a desired effect, find its cause and put that into action* [36].

By affirming the existence of a fixed underlying causal order, Thorndike's scientism dovetailed perfectly with the central goal of scientific management: determining the most efficient system of production for any process. For example, since he defined teaching as simply 'the art of giving and withholding stimuli with the result of producing or preventing certain responses', Thorndike maintained that educational research must identify those methods that are most effective in bringing about the social goals of schooling [37]. Such scientifically proven practices, when combined with a system of training and supervision, could then replace the traditional rule of thumb strategies employed by the average teacher.

For Thorndike, as for other efficiency theorists, there was a fundamental difference between the mind of the worker and that of the expert. Where the thought of the former was grounded in perception and coloured by opinion, the latter was able to generate objective judgments based on facts. On the whole, Thorndike cautioned, ordinary people were better off not thinking for themselves but following the wisdom of their intellectual superiors. Social progress depended upon the creation of a paternal society, cemented by sentiments of stewardship and deference, in which the cognitive élite were vested with the power to direct the masses towards the common good. In the case of schooling, this natural order was reflected in a system where researchers and adminis-

trators provided scientific knowledge and organisational control while teachers contributed their labour and unconditional loyalty.

Thorndike's views of learning, intelligence and scientific management provided the bureaucratically-minded educators of the era—the men David Tyack and Elizabeth Hansot have called the 'administrative progressives'—with the tools necessary to atomise, sequence and monitor every aspect of schooling [38]. As Herbert Kliebard observes, for curriculum designers such as Frank Bobbett and W. W. Charters, Thorndike's concept of the mind as a mass of localised stimulus-response bonds operated like a blueprint, justifying the breakdown of studies into the elemental components that would prepare each individual with 'the exact skills for the tasks that lay before them in life' [39]. Indeed, it was Thorndike's own research into the basic tenets of faculty psychology that provided the scientific efficiency movement with its most effective argument for undermining the traditional humanist curriculum. In two celebrated experiments, Thorndike showed that there is little or no transfer of learning between domain specific tasks and that no subject is more effective than any other in developing a child's intelligence [40]. The classics had no special value in disciplining the intellect, and a general education, in contrast to Charles Eliot's famous claim, was not the best preparation for life. What really mattered was the student's native ability, the most able pupils in his tests showing 'large gains in intellect' irrespective of the 'studies they take' [41]. These results confirmed Thorndike's personal conviction that extended schooling was simply wasted on the average child, who, by occupying the teacher's time, diverted attention from the important task of educating the most intelligent. Interestingly, Thorndike also undermined the received opinion that adults are less able to learn than children [42]. And yet, while supporting adult education, he remained convinced that such schemes should be reserved for superior minds. Unlike many of his followers, Thorndike did not view lifelong education as a mechanism for combatting the inequalities of schooling and society.

Thorndike's own contribution to the industrialisation of education was prodigious. He devised rating scales to standardise and measure children's proficiency in handwriting, spelling, drawing, history and English comprehension, and sold millions of arithmetic textbooks that stressed drill, repetition and the 'overlearning' of basis skills. In part, the attraction of these books lay in Thorndike's rejection of 'mental gymnastics'; every exercise, and there were thousands of them, was keyed to vocational and life needs. Nor was there any fat on this practical diet. Not wishing children to form superfluous bonds, he made sure that his books used only the most common and easily comprehensible words. While Thorndike's study of vocabulary proved extremely valuable to teachers and publishers, culminating in the justly celebrated *Thorndike-Century* dictionaries, one can only marvel at his mind-numbing ten-year study of popular literature in which he singlehandedly recorded the frequency of words in approximately a quarter of a million pages of text [43]. These projects, along with his marketing of vocational and intelligence tests, made Thorndike a considerable fortune.

But even more than these practical instruments, it was through his vast theoretical *oeuvre* of more than 400 publications that Thorndike shaped his discipline. His *magnum opus*, the three-volume *Educational Psychology*, along with his *Introduction to the Theory of Mental and Social Measurements* provided definitive guides to improving classroom instruction and objectively assessing the results of learning [44]. It is from these texts that the first generation of American educational researchers learned about operational definitions, the concept of innate intelligence, laws of learning, correla-

tions, experimental design, treatment groups, hypothesis testing and factor analysis [45]. As Henry Suzzallo explained:

> More than any of the other educational psychologists, [Thorndike] sponsored statistical method, redivised it for a hundred variable types of inquiry, taught it to his students and headed with a professional associate or two, the whole movement to give educational thought and practice a scientific and dependable technique [46].

It was this understanding of the methods and content of educational theory that was disseminated throughout the American university and school system by the army of administrators and superintendents that Thorndike helped to graduate during his 40-year tenure at Teachers College.

But Thorndike's vision of an educational science cannot be captured in any catalogue of his technical innovations and practical contributions, for the central and sustaining core of his work was not a set of abstract principles, but a moral commitment to the Puritan life ethic he had imbibed during his youth. If religion could no longer sustain such values, Thorndike, like many of his peers, was convinced that psychology could be used to reconstruct a virtuous and rational society free of the political corruption and haphazard practices that had infected American life. While such a scientifically organised community could arrest moral decay and eliminate inefficiency, it did not hold out the promise of democratic reform. Grounded in a mechanistic understanding of human nature, the concept of growth was simply not part of Thorndike's vocabulary.

JOHN DEWEY

Organicism and the Adaptive Mind

Like Thorndike, Dewey also wrote a classic in the history of psychological thought. Published in 1896, 'The reflex arc concept in psychology' marked a watershed in Dewey's thinking [47]. From a crucible of conflicting ideas—his early philosophical commitment to Hegelianism, contemporary attacks on mechanism within the life sciences, the influence of Darwin, and the psychological writings of William James—Dewey forged an organismic ontology to replace both the traditional Cartesian dualism of mind and body and its contemporary parallel, advocated by Thorndike, the physical dualism of stimulus and response. For Dewey, mind was not a spiritual entity existing over and above the material world—a spectator reacting to physical events. Nor was it an epiphenomenon generated by the brain. In Dewey's new synthesis, mind was to be understood as a functional product of the evolutionary process: it was a person's collective dispositions to *act*, the 'system of beliefs, desires, and purposes which are formed in the interaction of biological aptitudes with a social environment' [48]. Accordingly, while Dewey defended efforts to establish a naturalistic psychology, he rejected the passive and atomistic picture of mind presented by associationist learning theories such as Thorndike's in which the traditional triad of sensation, thought and action was replaced with a *causal* chain—modelled on the physiological reflex—that linked sensory input via neural pathways to distinct behavioural responses. As Dewey saw it, this mechanism fragmented action and failed to capture the central role that consciousness plays in human life. Men and women, he maintained, do not simply respond to the world; they strive, struggle and plan, and in so doing transform their spontaneous energies into the habits and behaviours necessary to achieve their goals.

The problem of life, therefore, was not to explain how either thought or experience initiates action, but how action generates thought in the course of adaptation.

As Dewey's analysis of a basic act demonstrates, even the simplest movements have a holistic, dynamic and developmental quality. Just as physiological systems maintain an equilibrium between the organism and its environment, so, Dewey argued, every action must be understood as a series of adjustments in which compensating processes resolve an initial nervous irritation. Thus, whereas William James attempted to identify the separate components of the reflex arc in his famous picture of a child reaching for a candle—the sight of the flame (stimulus) causing the movement of the arm (response)—Dewey offered a more subtle description in which seeing and reaching were interpreted as coordinated acts: vision guiding the hand as the hand directs the eye toward the goal of the light [49]. In contrast to the mechanical character of the reflex, Dewey's analysis of action thus stressed both the purposive nature of human behaviour and the complex, modifiable 'circuits' behind even the simplest movements. For Dewey the real beginning of the child's behaviour is the act of *seeing*, 'it is looking, and not a sensation of light' [50]. Moreover, he argued, stimulus and response should not be viewed as 'separate and complete entities in themselves, but as divisions of labor, functioning factors within the single concrete whole'—a system of compensating behaviours in which the coordinated hand-eye action would be transformed into the mediated circuit 'seeing-of-a-light-that-means-pain-when-contact-occurs' [51]. It is this model of unified, adaptive and integrated transactions in the balancing exchange between internal and external conditions that underwrites the organic understanding of life permeating Dewey's mature work, an understanding which, by affirming the primacy of activity, led Dewey to reformulate the central questions of philosophy. Where previous thinkers had sought secure foundations from which to justify reason and conduct, Dewey examined how people could develop the intelligent habits and character necessary to gain rational control of experience.

Science and the Democratic Life

At a time when the majority of American social scientists, Thorndike included, promoted the concept of a biologically fixed human nature, usually with an attendant hierarchy of race and gender, Dewey showed that genetic psychology must abandon its physiological basis and view the mind as a product of social adaptation. Dewey's argument is perhaps best understood when set against the work of Wilhelm Wundt [52]. Although usually remembered in Anglo-Saxon scholarship for his experimental analysis of 'inner perceptions', Wundt always maintained that introspective reports could not explain higher mental processes: *Naturwissenschaften* merely revealed the psychic equivalents of basic physical stimuli. Like his German contemporary Wilhelm Dilthey, Wundt recognised that because human beings are historically embedded in the language, religion and customs of culture, the mind must be understood through *Geistwissenschaften*—a project he pursued through the ten volumes of his massive *Völkerpsychologie* [53]. While such considerations were alien to Thorndike's atomistic view of individuals and society, Dewey fused his organic theory of activity with the teachings of Wundt's former student, his colleague and closest friend at the University of Chicago, George Herbert Mead. It was Mead's psychology, Dewey later confessed, 'that worked a revolution in my own thinking', and led to the recognition that 'all *human* experience is essentially social' [54].

Dewey's focus on the cultural determinates of thought can be seen in 'Interpretation

of savage mind', where he argues that the intelligence of native peoples can only be appreciated once it is understood how their traditions and practical occupations have developed to satisfy their daily needs [55]. But, while recognising that men and women are historically situated creatures whose thought and values are shaped by social institutions, Dewey was careful to avoid Marxism. In contrast to both biological and social determinists, he was adamant that 'the possibility of freedom is deeply ingrained in our very beings' [56]. Given the appropriate economic and political conditions, all individuals can acquire the critical habits necessary to gain rational and reflective control of their lives. Clearly, Dewey conceded, in primitive cultures—as in modern totalitarian states—where thought is constrained by religious and political orthodoxy to accept the wisdom and dictates of a ruling élite, men and women can be molded into passivity. But such authoritarian visions of the social good could no longer be sustained. Since Darwin, belief in universal truths and values had crumbled before the reality of a precarious and uncertain world: change and adaption were now the facts of life. Without the guidance of such fixed ends, progress depended upon society's ability to harness the most efficient system of problem solving. In Dewey's mind this implied a form of community life in which all citizens participated in the experimental determination of social policies. Ideas had to be evaluated by their consequences not their authorship.

Dewey spent a great deal of time trying to clarify the process of scientific reasoning and determine how it might be taught to children. Applying his organismic model of experience, he defined science, intelligence or reflective thought as the systematic method of resolving doubt, the controlled transformation of a troubling situation into a unified and satisfying whole. As he explains in *How We Think*, five distinct stages can be identified in the formation of any belief [57]. Starting from a felt difficulty, a problem is articulated, hypotheses are suggested, their implications are considered, and experiments are conducted to determine their truth. What turned this general scheme into science was simply the careful regulation of thought to ensure the full and objective consideration of all the conditions that surround judgment. In other words, science was the exercise of those cognitive virtues such as honesty, fairness, openness, and thoroughness that are implicit in the toleration of different viewpoints, the fostering of public criticism, and the willingness to share ideas. Where Thorndike presented science as a technical pursuit limited to superior minds, Dewey saw it as a universal method of deliberation *everyone* could and should employ. Indeed, Dewey observed, the rational values implicit in the scientific method were nothing less than the moral norms of democratic life.

Because Dewey defined democracy as a form of life rather than a set of government institutions, he was convinced that social reform could be achieved only when individuals were educated in the intellectual skills and social virtues necessary for democratic citizenship. And yet the traditional school, with its economy of abstract learning, punishment and competition, had generated a mentality of fear, greed, selfishness and individuality. The social spirit and abilities that Dewey prized demanded a radically different form of organisation that would utilise diverse talents and promote cooperation in joint problem-solving activities. To this end he proposed that schools be set up as embryonic democracies, where, through participation in shared tasks, the crude and immature powers of children would be honed into the social skills demanded by the scientific method. A democratic counterpart of Plato's utopian state, Dewey's organic society, like the idealised New England community of his youth, rested upon two goals: achieving the full realisation of each person's powers and ensuring the participation of

all 'in proportion to capacity in shaping the aims and policies of the group' [58]. As such, the common criticism that Dewey promoted *laissez-faire* policies of child-centred education is thus totally misplaced [59]. His vision of schooling was no more an exercise in romantic pedagogy than it was a preparation for a life of compliance under a heterogeneous authority, as Clarence Karier has claimed [60]. Neither the open nor the traditional classroom—individualism nor collectivism—would serve the needs of Dewey's social ideal. Reformulating the educational debates of his day, Dewey showed that the aims of self-realisation and socialisation were one-sided abstractions generated by the theoretical separation of the child and the curriculum. True, to be meaningful, learning must start from the spontaneous interests of the student—the spirit of the scientific mind so often destroyed by traditional methods—but equally, schooling should also lead to the development of what Dewey termed *social intelligence*: the ability to employ the tools of thought constructed in society's historical struggle to gain control of experience. As Dewey explained to the teacher, these were simply the psychological means and logical ends of a single process:

> Such and such are the capacities, the fulfilments, in truth and beauty and behaviour, open to these children. Now see to it that day by day the conditions are such that *their own activities* move inevitably in this direction, toward such culmination of themselves. Let the child's nature fulfill its own destiny, revealed to you in whatever of science and art and industry the world now holds as its own [61].

Such an education, of course, would demand a new kind of teacher and a new kind of school.

Dewey was well aware that philosophical arguments alone would not challenge the entrenched assumptions of American educators. An alternative paradigm had to be constructed in order to demonstrate how the school could be transformed from an instrument of social reproduction—reinforcing the divisions and inequalities of a fractured state—into the 'midwife' of a more just community. Not only did this involve rethinking the curriculum; it also meant reformulating the tasks of research, administration and teaching according to Dewey's concept of democratic organisation. It was to further these goals that Dewey established the laboratory school at the University of Chicago. Modelled on the chemistry and physics laboratory, Dewey attempted to construct a controlled environment for the development of *educational* knowledge. If staff, students, and material conditions varied from those found in the public system, he nonetheless believed they were similar enough to provide 'an experimental station for the testing and development of methods, which when elaborated, may be safely and strongly recommended to other schools' [62].

Central to Dewey's project was the rejection of any effort to turn education into a science by grounding its practices in the laws of some foundational discipline, as Thorndike had done with psychology. For while Dewey certainly believed that practitioners should draw upon all useful scientific findings, he emphasised that such knowledge would only become part of an *educational* science when it was shown to solve educational problems. *Practice* was 'the beginning and close' against which all experimental thought had to be judged [63]. 'The beginning, because it sets the problems which alone give to investigations educational point and quality; the close, because practice alone can test, verify, modify and develop the conclusions of these investigations. The position of scientific conclusions is intermediate and auxiliary' [64]. As with arts such as engineering or medicine, Dewey believed that teaching would only become

scientific when educators learned to replace their naive and uncritical assumptions with informed and intelligent habits. Such knowledge would not be 'found in books, nor in experimental laboratories, nor in class-rooms where it is taught, but in the minds of those engaged in directing educational activities' [65]. Teachers were not technicians following the dictates of university-based experts, as Thorndike had argued, but problem solvers who must inevitably generate their own practices. As Dewey explained, 'enlightenment, clarity and progress can come about only as we remember that [disciplines such as psychology and sociology] are *sources* to be used, through the medium of the minds of educators, to make educational functions more intelligent' [66].

While agreeing with Thorndike about the universality of the scientific method, Dewey had a more sophisticated understanding of the complexity of educational phenomena. He recognised that because human beings are purposive, conscious *subjects*, who create meaning and organise behaviours in order to secure their needs within multilayered social and historical fields, basic experience was not quantifiable, as Thorndike had argued, but irreducibly qualitative and rational. Of course, the artificial and abstract conditions of the psychology laboratory can yield law-like regularities, but such situations are so remote from real life that Dewey thought they would be of little use to the teacher. Research had to be conducted within a school where children could be studied as social beings. If this increased the dimensionality of the situation, Dewey was convinced that the scientific method, as he defined it, would yield practical and generalisable results. Most importantly, in contrast to Thorndike's concern with instrumental means–end questions, the laboratory school would also contribute to the experimental determination of educational aims. *Techne*, *praxis* and *theoria* had to be brought under scientific control.

For Dewey, science was first and foremost a form of social activity. This can be seen most clearly in the curriculum of his laboratory school. Based upon the reconstruction of social skills, Dewey organised his students' work around the occupations that have maintained communities throughout history. While these activities reflected vocational tasks, Dewey's goal was not to prepare children for participation within the existing economy, but rather to show them how social progress depends upon the cooperative division of labour. Where Thorndike advocated specialised training combined with indoctrination in attitudes of obedience, Dewey envisioned a non-hierarchical community of learners working on the joint solution of practical problems. Not only would this process demonstrate the unity and meaning of knowledge in relation to its social function, it would also help students develop the intellectual habits and virtues necessary for the proper employment of the scientific method.

The logic behind the organisation of children's work also applied to the tasks of the school faculty. A great believer in workplace democracy, Dewey, unlike Thorndike, was convinced that 'upon the whole, through the free and mutual harmonising of different individuals, the work of the world is better done than when planned, arranged, and directed by a few' [67]. Just as students were expected to participate in organising their own studies, so teachers were fully engaged in the running of their school. In weekly meetings, all members of the staff met to assess students' progress, design the curriculum, and discuss new teaching methods; cooperation, personal initiative, and joint reflection replaced the top-down management of efficient-minded principals and superintendents. Of course certain administrative tasks demanded specialised skills, but such divisions of labour were achieved without creating an autocratic structure. Integration and the exchange of ideas replaced supervision and control. Indeed, seeking to extend

this cooperative network, Dewey encouraged teachers to form associations both within the broader community and with university faculty. As a result, parents, academics and local tradespeople became active participants in the life of the school, promoting the fuller involvement of the community in the education of its youth. Dewey also showed how teachers could contribute to the development of knowledge by recording and even publishing the results of their pedagogic observations and experiments.

Where Thorndike put his faith in experts, Dewey exalted teachers, for theirs was the supreme task of crafting the scientific mind from the immature powers of the child. Not only did this require a knowledge of subject matter and a practical understanding of psychology; it also demanded a sense of mission: the recognition that teaching was the agency by which a more democratic community could be engineered. Like Thorndike, Dewey had reconstructed an early crisis of faith through a scientific morality. But where Thorndike secularised the conservative values of the Puritan world view in his vision of a technocratic society managed by superior *men*, Dewey transformed his reverence for God into a natural piety for the ethical ideals that regulate the democratic life. It was the teacher, not the psychologist, who became the prophet of Dewey's social philosophy, 'the usherer in of the true kingdom of God' [68].

INSTRUMENTALISM: THEORY AS PRACTICE

At the beginning of this century, a time of immense social and intellectual upheaval, Edward Lee Thorndike and John Dewey formulated two distinct visions of the American school. Employing radically different psychologies, both men promised educational reform through the application of science. In Thorndike's conservative synthesis, where ability and character were thought to be determined largely by birth, this amounted to the construction of a hierarchical society governed by an intellectual and moral élite. Schooling, like manufacturing, was the means–end process of selecting and shaping raw material to meet social needs according to the laws of psychology and the principles of scientific management. In a more liberal and optimistic assessment of human abilities, Dewey argued that men and women could utilise the scientific method and work cooperatively toward the ethical and spiritual ideal of the democratic life. While employing a number of similar terms—situation, habit, intelligence, and so on—Thorndike and Dewey were thus guided by completely different ontologies and divergent views of human nature and the social good. But where Dewey's synthesis of organicism and anthropology led to the examination of these moral assumptions, Thorndike's fusion of mechanism and physics, by divorcing fact and value, presented technology as a neutral instrument for achieving externally determined goals.

In *Knowledge and Human Interests* Jürgen Habermas argues that far from emancipating men and women from oppression and dogma, the philosophy of science Thorndike endorsed has led to a new and more insidious form of enslavement—insulated from normative criticism, it has evolved into a bureaucratically situated, technology-spawning ideology that renders people powerless and apathetic objects of state control [69]. It is not that Habermas rejects science *per se*, rather the scientism of the positivist movement. Indeed, paralleling Dewey's effort to reconstruct reason in the modern world, Habermas attempts to reformulate the Aristotelian division of *techne*, *praxis* and *theoria* in order to map out the various ends that knowledge should serve. Consequently, he explains, while society has progressed through the increasing command of nature afforded by science, this *technical interest* does not encompass the whole of life. Men and women, as Dewey recognised, are also social animals whose well-being or

practical interest is contingent upon their ability to communicate within the webs of meaning and significance that comprise a culture—a form of rule-governed understanding that cannot be captured in the nomological net of positive science. Combining work and language, Habermas then describes how the economic forces which generate institutionalised power relations systematically distort communication and solidify contours of social domination that frustrate the inherent *emancipatory interest* of all human beings to achieve free and rational self-determination. Therefore, like Dewey, Habermas outlines a reflective social science—informed by ideology critique and the concept of an ideal speech community—that will lead men and women to a progressively more democratic and meaningful society.

Although Habermas has not written on education, as Gerry Ewert demonstrates, his analysis of knowledge has had an enormous influence on educational theorists around the world [70]. On one hand, his powerful exposé of technological rationality has demonstrated the dangers of scientism and revealed the extent to which positivist assumptions have permeated schooling and mainstream educational research. On the other hand, by defining the proper role of empirical, interpretative and reflective inquiry, he has shown educators how to reconcile quantitative and qualitative research while re-invigorating efforts, notably by Wilfred Carr and Steven Kemmis, to establish a *critical* science of education—developments Dewey surely would have applauded [71]. Indeed, following Habermas, Carr and Kemmis develop criteria for a practitioner-based, democratically ordered science of education that could have been written by Dewey himself.

> A critical educational science ... has a view of educational reform that is participatory and collaborative; it envisages a form of educational research that is conducted by those involved in education themselves. It takes a view of educational research as critical analysis directed at the *transformation* of educational practices, the educational understandings and educational values of those involved in the process, and the social institutional structures which provide frameworks for their action. In this sense, a critical educational science is not research *on* or *about* education, it is research *in* and *for* education [72].

But while agreeing with them on the goals for educational reform, Dewey's focus on the scientific *method* yields a number of important insights that can enhance Carr and Kemmis's program. For example, where Carr and Kemmis follow Habermas's analysis of human interests to chart the territory of educational research, Dewey, retaining Aristotle's functional perspective, examines the process of solving educational problems. Since Dewey held that knowledge, whether science, art or common sense, is simply an instrument for the control of experience, he maintained *theory must be understood as a form of practice*: an abstract intellectual construction, which, by generalising particular actions, permits public criticism, the formation of new ends and, through the requalification of concrete situations, the enrichment of meaning. Indeed, Dewey claimed, 'theory is with respect to all other modes of practice the most practical of all things, the more impartial and impersonal it is, the more truly practical it is' [73]. As such, rather than 'Theorising Educational Practices', Dewey, using his laboratory school as an experimental station for the creation of educational knowledge, focused on developing the practice of educational theorising [74]. Second, where Carr and Kemmis follow Habermas's reformulation of *techne* and *praxis* in order to undermine instrumental rationality, Dewey develops a positive critique of technology. He rightly

observes that *all* our transactions with experience are fundamentally open-ended. The scientist, the poet and the carpenter each solve problems by formulating 'ends-in-view', guiding constructs that direct the creative, experimental and evaluative interplay between human goals and the world. Progress is not achieved by turning teachers into technicians who follow the kind of means–end routines Thorndike advocated, but, as with other professions, ensuring that practitioners acquire the intellectual tools necessary to solve the problems of their field. In an open universe empirical, interpretative and critical reasoning have to be brought under scientific control. Third, while Carr and Kemmis, following Habermas, recognise that notions such as freedom, truth and justice are united in the concept of an ideal speech group, Dewey demonstrates the essential relationship between knowledge and community through his analysis of problem solving [75]. In Aristotle's scheme *theoria*, *praxis*, *techne* and *ponos* (the labour and suffering of the slave) were not only different forms of knowledge, but also referred to distinct stations in life and thus served as indexes of virtue. Turning this social hierarchy on its head, Dewey argues that without the foundational insights of an intellectual élite, knowledge must be built by educational workers from the bottom up [76]. Intelligence is not an individual possession but a social tool which can only be fully realised within democratically organised groups. Finally, the central role of the aesthetic in Dewey's logic adds an important dimension to standard criticisms of positivism [77]. For, in contrast to empiricist epistemologies, Dewey's instrumentalism assumes that experience is primarily non-cognitive: first and foremost life is something human beings suffer, endure and enjoy [78]. Thought only arises when the unity of this felt immediacy is disturbed. However, if inquiry resolves this tension, restoring the qualitative wholeness of the situation, then the resulting consummatory fulfilment becomes a source of meaning and value within experience. On this account, perhaps Dewey's greatest criticism of technological reason is the sheer dulling of life that results from the mechanistic routine of industrial labour. Thorndike's economy of rote learning, drill and standardised outcomes effectively reduces schooling to *ponos*, a monotonous regimen devoid of intellectual satisfaction that kills the inherent curiosity and inventiveness of childhood—the creative spirit of the scientific mind.

Bolstered by social and economic crises, the American university and the American school have become increasingly invested in Thorndike's research and development model in the hope that an expert knowledge base can be constructed for the scientific solution of educational problems. But insofar as it remains committed to global top-down strategies, to a naive equation of science with quantification, to the *objectification* of human nature, and to conservative notions of intelligence and morality as fixed biological traits, then educational theory will be of little practical value in solving the problems of the 1990s. Rather than reducing teachers to instruments of theory, Dewey, like Carr and Kemmis, demonstrated that we must learn to see theory as an instrument which teachers can use to improve their understanding of the educational process. Not only does this change of focus require a greater appreciation of the qualitative dimensions of experience and the nested complexity of educational phenomena, it also implies a basic reorganisation of the educational community. For embracing Dewey's vision of science as *the* method of rational deliberation involves committing oneself to a form of cooperative activity in which, through experimental and self-critical inquiry, all participants combine in the democratic construction of both the means and the ends of education—a goal of social intelligence and public virtue that will never be attained until 'the spirit of free intelligence pervades the organization, administration, studies, and methods of the school itself' [79].

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Correspondence: Stephen Tomlinson, Assistant Professor in Foundations of Education, 306 Graves Hall, University of Alabama, Tuscaloosa, AL 35487–0231, USA.