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3

Contemporary Qualitative Research

Toward an Integral Research Perspective

Peter Charles Taylor

A rather large group of individuals has taken a set of methods, devised an alternative paradigm/model/metaphysics for looking at the world, primarily utilizing those self-same methods; set about building new methods and fleshing out the repertoire; constantly adapted to changing social contexts (such as the advent of the Internet and the Web); integrated all of the best late 20th-century thinking about representation, texts, and Western authority; moved quite deliberately to make space for the margin(s) at the center(s); criticized ourselves incessantly in the interests of dealing with the field's problems, its issues, and its relationships with those whom we would study; built designs to encourage democratic practice and agency out in the fields; systematically thought through major answers to the questions that frame scientific inquiry (Lather, 2006); and set about healing the Enlightenment rift between art and science, between mind and body, between reason and spirituality, between logic and emotion, and between technical rationality and human invention. It is a rather great sweep of events, this past 25 years, and as I've tried to demonstrate, it is not over yet.

(Yvonna Lincoln, 2009, p. 8)

Since its border crossing from the social sciences around 30 years ago, qualitative research has been providing science education researchers with radically new perspectives for examining and transforming curricular policies and practices at all levels, up to and including teacher education and graduate research. However, despite the growing popularity of qualitative research, its full potential is far from being realized. There are two main reasons for this. First, qualitative research does not sit easily within the traditions of science education, especially among those who hold steadfastly to a worldview in which methods of knowledge production are regulated by the objectivity of the so-called scientific method. As a result, much qualitative research is designed to fit within this worldview as a supplement to quantitative research approaches, thereby blunting the sharp edge of its transformative potential.

A second and equally important reason concerns the nature of contemporary qualitative research, which is notorious for having evolved into a complex, chaotic, and contested field. Its complexity is due to the multiparadigmatic nature of the field. Several interacting research paradigms govern contemporary qualitative research, providing diverse theories about how to understand our relationship with reality, how to make legitimate sense of and represent our experiences, and how to act in accordance with how we value ourselves, others, and our environments. Making a coherent choice of qualitative research design principles from among this complexity can be confronting for both novice and expert researchers. Furthermore, the field is chaotic inasmuch as there is no agreed-on best taxonomy of qualitative research approaches, designs, or methods. This has given rise to a profound lack of consensus on the crucial question of how to optimize the "validity" of qualitative research, with many scholars rejecting the term and proposing alternative quality standards unique to qualitative research.

To add to the discomfit of novice researchers, the term "qualitative" is now being contested as a suitable descriptor for the field, with many arguing that the "qualitative-quantitative" distinction is well past its use-by date. How did this come to pass? The qualitative research pioneers of the 1990s raised our awareness of the narrow (and largely invisible) assumptions underpinning much of our research and began the process of contesting the privileged status of the dominant quantitative (or "scientific") perspective we had imported from the natural sciences. The resulting "qualitative versus quantitative" clash of civilizations eventually generated a more sophisticated and nuanced understanding of the philosophical foundations of educational research. Practitioners of the contrasting schools engaged in productive dialogue and began to cross-fertilize their research designs with methods from the other camp to produce "quantitative and qualitative" research designs, known more recently as "mixed-methods" research. Today,

qualitative methods such as interviewing are incorporated into quantitative research designs, and qualitative research designs at times make use of quantitative methods such as questionnaires.

So when we use the adjectives "qualitative" and "quantitative," what do we actually mean in this new era of hybrid research designs? Are we distinguishing among contrasting types of data or research methods or research designs, or are we making a distinction based on something deeper, more profound, such as fundamentally different ways of producing, representing, and legitimating knowledge? For many novice researchers sorting through the plethora of textbooks on the subject, where complexity, chaos, and contestation abound, linguistic confusion begets conceptual confusion; more questions than answers tend to arise.

As an experienced practitioner of contemporary qualitative research I have the challenging task of writing a chapter that brings some order and insight to our understanding of the field while being careful not to overreach myself in a vain attempt to settle, once and for all, the complexity and contestation characterizing the discourse of its proponents. I shall, at least, endeavor to reduce the chaos. A hallmark of contemporary qualitative research is its transparency, with researchers making visible their engagement in the inquiry process. In writing this chapter, I did, in fact, engage in an interpretive process of *writing as inquiry* (Richardson, 1994) wherein I obtained "data" by sampling the vast literature on qualitative research and reflected on how, in my professional capacity as a researcher and graduate research teacher, I have helped my graduate students conceptualize the field and find productive ways of designing and conducting their inquiries. The result is, therefore, a necessarily partial account of a dynamic and emergent scholarly field.

Rather than duplicating the many textbooks on qualitative research that focus on methods of producing and processing qualitative data (oftentimes overlooking important framing assumptions), I have chosen instead to focus this chapter on the main philosophical, sociocultural, historical, and political influences shaping contemporary qualitative research and on its exciting prospects for transforming science education. In the absence of these theoretical considerations, it is highly unlikely that the transformative potential of contemporary qualitative research can be realized.

I have chosen also to use a largely expository style of writing rather than the usual narrative style that makes transparent the process of qualitative inquiries, especially the researcher's unfolding subjectivity. In making this choice, I took into account the general predilections of the audience of this handbook and the advice of my reviewers and editor. To compensate for this conservatism (some might call it "heresy"), I direct the reader to other publications in which illustrative exemplars of contemporary qualitative research writing can be found.

To untangle the linguistic and conceptual knot I refer to, it is helpful to understand the origins of qualitative and quantitative research. To this end, I start with a brief historical account.

Historical Roots of Quantitative and Qualitative Research

A succinct account of the historical emergence of qualitative research is given by David Hamilton (1994), who argues that "The epistemology of qualitative research . . . had its origins in an epistemological crisis of the late eighteenth century" (p. 63). Earlier in the 17th century, Rene Descartes's *Discourse on Method* (1637) had created the philosophical foundations of quantitative research: reasoning based on empirical objectivity and mathematical certainty, known as Cartesian absolutism. Almost 150 years later, Immanuel Kant's *Critique of Pure Reason* (1781) proposed a contrasting model of human rationality in which the mind has a central role in shaping perception and mediates our (interpretive) understanding of the natural world. Kant established the role of the investigator's subjectivity as central to his/her inquiry of natural phenomena, thereby laying the epistemological foundations for qualitative research in the social sciences.

The contrast between these two schools of thought is stark. Cartesian objectivity, which separates the observer from the observed, serves the production of universal law-like knowledge of causal relationships among naturally occurring phenomena on the basis that the material universe is strongly deterministic: given knowledge of initial conditions, the final state of affairs can be predicted with certainty. There is little room for self-determination or free will in a Cartesian worldview. Isaac Newton was embedded in the Cartesian worldview when he formulated the fundamental laws of motion of a seemingly clockwork universe. Cartesian objectivity is the *sine qua non* of the classical quantitative research model of the physical sciences.

By contrast, a Kantian perspective adds a moral dimension to human reasoning about practical matters affecting our lives, giving rise to *practical knowledge* grounded in everyday experience. A Kantian perspective is concerned with human freedom and social emancipation and focuses attention on moral decision-making in acts of self-determination. In the 19th century, neo–Kantians such as Wilhelm Dilthey helped establish qualitative research for the social sciences with an epistemological emphasis on the role of "understanding" (or *Verstehen*) and "lived experience" (or *Erlebnis*), which contrast sharply with the Cartesian concept of "explanation" (or *Erklaren*). For neo–Kantians, the observer and observed are intimately interconnected in a dialectical relationship, with one affecting the other and vice versa. Interestingly, quantum theory has a similar perspective, with the conscious mind of the observer collapsing the "probability wave function" through an act of observation (or measurement) to produce a particular physical manifestation, one of many possible realities. The paradox of the life or death of Schrodinger's Cat is a

classic example. Quantum theorists propose that not only subatomic phenomena but all of life, especially human consciousness, is subject to this quantum effect (e.g., Goswami, 1993; Rossenblum & Kuttner, 2011).

In the 19th century, a neo–Kantian perspective gave rise to the emancipatory role of the social scientist as social activist working with underprivileged sections of society to empower them with the freedom and means to respond to the repressive social conditions of their lives. This emancipatory sentiment—applied research as/for social justice—flowed through into the 20th century, where it was taken up by critical social philosophers of the Frankfurt School, such as Jurgen Habermas (Habermas, 1972), and brought into the field of education by critical action researchers such as Wilfred Carr and Stephen Kemmis (e.g., Carr & Kemmis, 1986).

But the foregoing account gives a distorted version of history if the reader concludes that 20th-century social science research witnessed the demise of quantitative research and the ascendency of qualitative research. Notwithstanding successful philosophical critiques of the Cartesian/Newtonian scientific paradigm by philosophers such as Paul Feyerabend, Thomas Kuhn, Imre Lakatos, Karl Popper, Ilya Prigonone, and Stephen Toulmin, alongside critiques of the supportive Platonist and formalist philosophies of mathematics by Kurt Godel and Morris Kline, quantitative research, albeit in a modified form, retains a powerful presence in the social sciences, especially in science education. The reason for this has little to do with the intellectual merits of philosophical debate and much more to do with the pendulum swing in politics to right-wing "neoconservatism" throughout the Western world during the past 30 years (e.g., Smith, 2008).

Yvonna Lincoln (2005) provides a compelling explanation of the new era of "methodological conservatism" policed by governments and institutional (university) review boards that require "scientific evidence" of the success of their economic rationalist management policies—a model that necessarily equates greater system efficiencies, higher productivity, and increased accountability with "improved" teaching and learning outcomes. Funding for quantitative research approaches that promise to provide this scientific "proof" was prioritized in the run up to the turn of this century. Ernest House (2006) attributes this "methodological fundamentalism" to the United States federal administration, which espoused the ideological policy belief "that only randomized experiments could produce true findings," a proposition that House interprets as a thinly disguised attempt to "restore traditional authority relationships" (p. 93).

In a similar vein, postcolonial scholars warn that overt political control of social science research is reminiscent of the one-size-fits all curriculum ideology imposed by European nations on their colonies in the 19th century in an endeavor to "civilize the natives" by cultural identity and linguistic replacement "therapy" masquerading as school education (see, for example, Haarman, 2007;

Mutua & Swadener, 2004; Nhalevilo, 2013). And it is also resonant of current graduate programs in Western(ized) universities that indoctrinate students in the Cartesian/Newtonian worldview of quantitative research with little or no regard for epistemological pluralism (Paul & Marfo, 2001).

A useful way to understand the state of play of educational research today is to examine contemporary social science research textbooks. When I started teaching research classes in a graduate school of science and mathematics education in the 1980s, the main textbooks of the day (Tuckman, 1978) presented only quantitative research; the term "epistemology" was absent and the Cartesian/Newtonian worldview exercised a hegemonic stranglehold over graduate students' (and their supervisors') understanding of the nature and purpose of educational research. In metaphorical terms, the fish were largely unaware of the water in which they were swimming (e.g., Taylor & Medina, 2013).

As a transformative educator seeking to instill higher-order consciousness, I find myself in agreement with Yvonna Lincoln (2005) that developing comprehensive understanding of research epistemologies should be a core goal of graduate research education. In order to escape the hegemonic grip of the Cartesian/Newtonian worldview, especially for science educators for whom it is akin to "mother's milk," and to be able to exercise informed choice (which involves freedom to choose qualitative or quantitative research approaches), graduate students need to be epistemologically astute, that is, critically aware of the assumptions about the nature of knowledge underpinning the processes of research knowledge production.

Today, there is a large range of offerings in social science research textbooks. While some authors are concerned largely with the technicalities of implementing research methods (e.g., Creswell, 2012), others prefer a philosophical perspective that classifies research in terms of paradigms, comparing and contrasting their ontologies, epistemologies, and methodologies (e.g., Bryman, 2012; Cohen, Manion, & Morrison, 2011; Guba, 1990; Howell, 2013; Willis, 2007). The following set of four paradigms is commonplace in contemporary social science research textbooks.

Post-positivism
Interpretivism
Criticalism
Postmodernism

There is lack of consensus, however, on precisely how to map the terms "quantitative research" and "qualitative research" onto this four-paradigm taxonomy. The popular mixed-methods perspective (formerly known as "quantitative and qualitative research") suggests that qualitative research methods can be combined unproblematically with quantitative research methods. Later in the chapter, I explain that this is feasible but restrictive, as it tends to

result in research designs governed by the epistemology of the post-positivist paradigm. A contrasting view, which resonates with me, is that quantitative research is governed by the epistemology of post-positivism, whereas contemporary qualitative research is affiliated with the multiple epistemologies offered by the interpretive, critical, and postmodern paradigms. This lack of consensus explains why many graduate students find the field of educational research to be incoherent and confusing. Before considering the first of the qualitative research paradigms, we shall consider, as a point of departure, the characteristics of the positivist paradigm that governs traditional quantitative research in science education.

Beyond Positivist Research

Underpinned by Descartes's philosophy of reasoning based on empirical objectivity and mathematical certainty and concerned with uncovering the law-like properties (Dilthey's *erklaren*) of the material universe, the paradigm of positivism (or empiricism) has become synonymous with "the scientific method." Quantitative research approaches that seek the elusive goal of proving causality are designed to control as much of the experimental conditions as possible (to minimize statistical variance or the "noise-to-signal" ratio). The purpose is to test the legitimacy of a carefully crafted *a priori* theory. In agricultural science, researchers compare the yield of a genetically modified crop with the yield of a standard unmodified variety. In particle physics, high-energy beams of subatomic particles are collided under rigorously controlled conditions to track their trajectories; the recent near-confirmation of the existence of the Higgs-Boson particle is an exemplar of this approach.

In the late 19th century, the successful experimental research approach of the physical sciences was imported into the social sciences to achieve, among other things, academic legitimacy for this new discipline (Schon, 1983). Classic positivist research designs for examining human behavior feature control and treatment groups, pre- and posttests, randomized sampling, and large sample sizes. They are regulated by the gold standard of objectivity embodied in various forms of validity and reliability. Social science research writers have associated the positivist paradigm with the *principle of verificationism*, which drives researchers to collect empirical (i.e., sensory) data to confirm their *a priori* hypotheses, and with the *correspondence theory of truth*, which drives researchers to claim to have discovered accurate descriptions (rather than interpretations) of reality, often labeled as an ontology of *naïve realism*.

It is easy to appreciate why science educators are attracted to positivist research when we reflect on the way science (our primary discipline) has been represented in traditional undergraduate university science curricula as objective and uncontestable facts. A perception of the implacable objectivity of science has been reinforced by didactic teaching methods, "cookbook-type" laboratory experiments, and a museum-like encounter with the end-products of scientific research rather than with the messy (inter/subjective) processes of creative discovery and consensual validation that produced them (Kuhn, 1962).

For educational researchers, a disadvantage of positivist research is that because the results have a large "grain size," they are usually insensitive to local contexts and individuals, be they a particular school or teacher or class or student; we learn nothing about the "small dots" (especially the outliers) that make up the big statistical picture of ANOVAs, regression equations, or mean scores and standard deviations. Furthermore, because quantitative research designs and methods can be unwieldy and time consuming to implement, requiring a team of specially trained academic researchers to employ them, they are seldom of use to individual teachers, thereby reinforcing the traditional *theory–practice gap* of research serving primarily the interests of academic researchers over teacher practitioners.

But perhaps the decline in the popularity of positivist research can be largely attributed to the recent rapid rise of research ethics committees (in universities, schools, state authorities) that require researchers not only to avoid harm (i.e., non-maleficence) but to make a positive contribution (i.e., beneficence) to research sites (Cohen, et al., 2011). The critical question arises as to who benefits from the research and who does not. In Western democracies, many school communities no longer regard as ethically acceptable the experimental research practice of dividing students randomly into treatment and control classes and applying a teaching innovation to the former while withholding it from the latter. A teaching innovation must be preapproved as highly likely to make a positive contribution to the curriculum, in which case an ethic of fairness dictates that it should be applied to all students in the cohort. Few parents would be pleased to have their school-aged child treated like a "lab rat" in the interest of science. As part of this *ethical turn*, democratic institutions are increasingly observing the principle of social equity. This has leveled the professional playing field, resulting in academic researchers no longer having the privileged status they once enjoyed; they can no longer necessarily expect to "command" schools to comply with their large-scale data collection wishes.

During the closing decades of the 20th century, in the social sciences the classical paradigm of positivism underwent an epistemological softening; it was retuned to better serve the interests, structures, and priorities of local communities in which educational researchers wished to work. Although post-positivism shares with its parent paradigm a philosophy of reasoning based on empirical objectivity and mathematical certainty, it has taken a step away from the scientific (moral?) high ground of proving causation and has settled for establishing the next best thing: correlation, or compelling evidence that key variables tend to co-occur (or are associated) under given circumstances. This has

resulted in the deregulation of quantitative research, with a wide range of contemporary research designs: quasi-experimental designs that dispense with a control group, correlational designs that dispense with pretesting, and survey designs that dispense with sampling across time. Sampling theory now includes non-random sampling, purposive sampling, and convenience sampling, among others, and sample sizes have shrunk to as small as a single class size of, say, 25 students.

The striking feature of many post-positivist research designs is the addition of *qualitative research methods*—observational checklists, (semi-)structured interviewing—as a supplement to the primary quantitative methods, giving rise to hybrid labels such as "quantitative and qualitative research" and "mixed-methods research." Objectivity continues to serve as the gold standard, but it too has softened, with changes to the ways in which validity and reliability are optimized. Although the observer–observed dualism continues, the researcher–researched relationship is far less clinical and clear cut. It is commonplace for university researchers to work with teachers in school classrooms to facilitate improvements to teaching and learning, with teachers being empowered as co-researchers.

More than this, post-positivist research has enabled teachers themselves to adopt independent teacher-researcher roles as a core aspect of in-house professional development. For example, armed with a university-designed questionnaire that has been previously validated for obtaining measures of students' perceptions of selected aspects of the learning environment, a teacher undertakes an *action research* study for the purpose of improving a particular aspect of student learning, such as the ability to work collaboratively in small groups on an open-ended inquiry. The questionnaire provides a scholarly theoretical framework for shaping the teacher's innovative teaching approach and, when used as a post-test, generates class mean scores that provide a handy snapshot of the perceptions of the whole class. Subsequently, semistructured interviews with selected students help confirm (or perhaps disconfirm) the validity of the quantitative pattern.

In this case, the theory–practice gap has narrowed, but there is still a one-way bridge to cross, with "expert" theory being imported under the assumption of it having universal applicability regardless of the local sociocultural context. Although the teacher-researcher has much greater involvement in controlling and applying the research, this form of mixed-methods research, which is growing rapidly in popularity among science educators, serves to implement a normative theory of teaching and learning, the standards of which are embedded implicitly in the questionnaire. This normative (critical theorists would say "covert") purpose is very different from *emancipatory research* that aims to enable teachers to generate what Jean McNiff and Jack Whitehead (2011) call "living educational theory" grounded in the unique authority of teachers' own professional experiences. I am not suggesting, however, that the importation of academic theory is necessarily a weakness

of post-positivist research or that mixed-methods research serves a sinister purpose. Rather, I am arguing that this form of research, as with all research, is limited in what it can achieve and that this limitation should be recognized, especially in graduate research schools.

Interpretive Research

> Kant revived a distinction, found in Aristotle, between theoretical and practical knowledge. Theoretical knowledge refers to states of affairs whose existence can be checked, tested, and accepted. Practical knowledge . . . refers to decision making . . . Practical reasoning . . . relates, therefore, to the application of moral judgments in the realm of human action.
>
> (Hamilton, 1994 p. 63)

An intellectual revolution in the social sciences started in the United Kingdom during the 1970s to 1980s: qualitative program evaluation and qualitative case studies became prominent among scholars in the field of education and training (e.g., Hamilton, 1977; Simons, 1980; Walker, 1980). In the United States during the 1980s, Jim Gallagher (1991) introduced interpretive research into science education, drawing on the scholarship of educational anthropologist Frederick Erickson (1986), who had based his ideas on the German social science tradition of *hermeneutic-phenomenology*.

> Interpretive research is the name given to a family of approaches that includes ethnographic, qualitative, participant-observational, case study, phenomenological, symbolic interactionist, and constructivist research . . . This line of research arose over 100 years ago as an attempt by German intellectuals to distinguish between "natural sciences" and "human sciences". This distinction was viewed as necessary since humans differ from other animals and inanimate objects in their ability to make and share meaning.
>
> (Gallagher, 1991, p. 5)

The uniquely powerful feature of interpretive research is its explicit *social constructivist epistemology*, which directs science education researchers to ethnographic research methods—prolonged participant-observation, non-clinical interviewing, emergent analysis via grounded theorizing, and thick description. These qualitative methods enable interpretive researchers to construct insightful understandings of the "meaning-perspectives" (i.e., ideas, beliefs, values, worldviews) underpinning teachers' and students' classroom interactions. Interpretive researchers carefully document the context (physical, social, cultural) that shapes and, in turn, is shaped by participants' interactions, thereby generating practical knowledge of the complexity, context, and dynamics of teaching and learning.

Interpretive research arrived in science education at a fortuitous time: a "constructivist revolution" in teaching and learning was underway in the early 1990s. Constructivist theory was introduced into science curricula to create

meaningful learning environments that optimized students' engagement in making sense of their experiences. Constructivist teachers experimented with radically new metaphors of knowledge production in their classrooms, focusing on the quality of students' sense-making processes. Innovative researchers adopted person-sensitive methods of interpretive research to "look into" the hearts and minds of teachers and students, producing insightful understandings of the affordances and constraints of constructivist reform in science education (e.g., Tobin, 1993).

At the same time, mathematics education was undergoing a similar epistemological revolution. Researchers from both disciplines shared their innovative development of constructivist theories of teaching and learning and the empirical outcomes of their research (e.g., Eisenhart, 1988; Wheatley, 1991). An account of the constructivist transformation of science and mathematics education is beyond the scope of this chapter, but it is important to point out that two contrasting schools emerged—personal construct theory and radical/social constructivism—which employed qualitative research in markedly different ways.

Personal construct theory researchers, working from a traditional psychology-of-learning perspective, adopted a conservative approach to curriculum reform by applying constructivist theory to the focus but not the methodology of their research. They tended to work within the classical model of science, designing innovative teaching methods to correct students' errant understandings of conventional scientific concepts (i.e., misconceptions, alternative conceptions). Their preferred research approach was quantitative: using paper-and-pencil instruments to measure the extent of students' "conceptual change," at times correlating achievement outcomes with attitude and scientific reasoning. Later, when mixed-methods research was introduced, participant observation and structured interviews helped researchers validate their quantitative analyses, which, in turn, helped them validate their measuring instruments. The valuable but subordinate role of qualitative research methods within an overarching quantitative research design remains a frequently used mixed-methods approach in science education. However, it seldom involves an interpretive perspective.

By contrast, radical/social constructivists applied constructivist theory to both the focus and methodology of their research. They focused on rethinking the fundamental assumptions of science teaching and learning, reconceptualized classroom discourse as social inquiry, and designed interpretive studies to map the processes of constructivist teaching reforms as they worked collaboratively with teacher-researchers. Interpretive researchers were not simply observing classroom life but were deeply involved in interventions designed to make a difference: to the teaching and learning experience, to the pedagogy of the curriculum, to the nature and purpose of schooling, and to society at large. As the constructivist reform agenda expanded, so did perceptions of the nature and purpose of educational research. Interpretive researchers

moved away from the value-neutral standpoint of classical quantitative research to an interventionist role driven by a moral imperative to improve the human condition, leading them to embrace critical social theory and methods that are discussed in the section on critical research.

The 1990s were an exciting time to be an interpretive researcher in science education. The constructivist revolution in teaching and research was gathering pace with high-level scholarly support available from a rapidly growing network of social science researchers across many disciplines. Pioneering science education researchers, foremost among whom was Ken Tobin, introduced advanced scholarship of interpretive research into graduate research programs, spawning many studies of the social constructivist reform of science teaching and science teacher education in colleges and universities (Taylor, Gilmer, & Tobin, 2002).

As the *reflective turn* in the social sciences became increasingly prominent, many interpretive researchers shifted their focus from an ethnographic perspective on understanding the culturally different other to the active role of their own subjectivities in constructing that understanding. Guba and Lincoln (1989) defined the term "progressive subjectivity" to indicate the importance of the emergent quality of the researcher's self-understanding and the need to make this process transparent in their research reporting. The researcher as *reflective practitioner* had arrived (Schon, 1983), giving rise to diverse communities of scholars in institutions of higher education interested in improving their own professional practices.

The field of practitioner research is known variously as *self-study research* (Lassonde, Galman, & Kosnik, 2009; Pithouse, Mitchell, & Moletsane, 2010), *participatory action research* (Reason & Bradbury, 2001), and *living theory action research* (McNiff & Whitehead, 2011), although there are other variations on these terms. Practitioner researchers draw on personal experience methods (Clandinin & Connelly, 1994), biographical methods such as life writing and autobiography (Smith, 1994), narrative inquiry methods (Chase, 2005), and auto/ethnographic methods (Reed-Danahay, 1997). As discussed in the next two sections, they also draw on critical research methods and arts-based research methods to engage in writing as critical inquiry (Richardson, 1994) and to generate evocative research texts. In the third edition of the *Handbook of Qualitative Research*, we find that Egon Guba and Yvonna Lincoln (2005) have assigned the status of paradigm to the field of practitioner research. However, I am inclined to regard practitioner research as multiparadigmatic, with its practitioners drawing on any or all of the major paradigms discussed in this chapter, as will become clear in the later section on integral research.

The scholarly status of interpretive research has been strengthened by the scholarship of naturalistic researchers (Guba & Lincoln, 1988) and contributors to the *Handbook of Qualitative Research* (Denzin & Lincoln, 2005a). Interpretive research, with its underpinning social constructivist

epistemology and relativist ontology (multiple realities exist), is clearly differentiated from objectivism and various realisms of the classical positivist and post-positivist research paradigms. Norman Denzin and Yvonna Lincoln (2000) have identified three "crises" that have arisen in the field of social science research as a result of the emergence of new research paradigms. No longer is there a single best way to validate knowledge (*crisis of legitimation*) or to represent the experiences of the researcher and his/her participants (*crisis of representation*) or to enact the role of researcher (*crisis of praxis*). Each of these fundamental aspects of research depends on the governing paradigm. I shall now consider appropriate (and inappropriate) quality standards for legitimating interpretive research.

Quality Standards for Interpretive Research

Many qualitative researchers eschew validity and reliability as standards for legitimating their scholarly work, arguing that these gold standards are epistemologically irrelevant (e.g., Schwandt, 2001). As a result, a range of alternative criteria have arisen—for example, descriptive adequacy, fidelity, accuracy, comprehensiveness, plausibility, believability, authenticity, consistency, coherence (in Green, Camilli, & Elmore, 2006), or cogency, efficacy, potency, punch, and persuasiveness (Wolcott, 1990). This diversity makes it very difficult for novice researchers to know which criteria to select. For interpretive research, two complementary sets of quality standards were designed by naturalistic researchers Egon Guba and Yvonna Lincoln: *trustworthiness* and *authenticity*. These twin standards have been uniquely designed in accordance with the epistemology of social constructivism, as explained initially in *Fourth Generation Evaluation* (Guba & Lincoln, 1989) and later in the *Handbook of Qualitative Research* (Guba & Lincoln, 1994). Here I shall outline these standards before considering the popular standard of triangulation and the less well-known alternative for contemporary qualitative research, crystallization.

Trustworthiness. There are four trustworthiness criteria: *credibility*, *transferability*, *dependability*, and *confirmability*. Implementing these criteria helps ensure that researchers construct deep understandings of the meaning-perspectives of their participants, understandings that emerge from prolonged immersion in their participants' social worlds, that have been verified through "member checking," and that have been challenged by seeking evidence to disconfirm inferences arising from grounded theorizing. Importantly, trustworthiness is optimized also by researchers making visible (i) the context of participants' social worlds by means of "thick description" and (ii) the process of fieldwork inquiries by means of narrative writing in which their unfolding subjectivities are expressed in the first person (i.e., "I" and "we") voice with probabilistic reasoning (i.e., "it seems that . . .," "it appears that . . .," "it is likely that . . ."), thereby conveying the implicit uncertainty of interpretations. The availability of literary genres

(discussed later in the section on postmodern research) provides contemporary interpretive researchers with richly expressive means for writing trustworthy accounts of their inquiries.

The trustworthiness criteria address methodological issues that are "parallel to" the positivist standards of internal and external reliability and validity. Guba and Lincoln's explicit mapping of the interpretive criteria onto the positivist criteria is of great assistance to science education researchers endeavoring to make the counterintuitive epistemological border crossing from the positivist to the interpretive paradigm. However, Valerie Janesick (1994) has warned of the danger of "methodolatry" (i.e., worshipping method) that arises from focusing fixedly on methodological criteria to the extent that relationships with one's participants are distorted by the researcher's academic self-interest.

Authenticity. The second set of interpretive research standards—*fairness*, *ontological authenticity*, *educative authenticity*, and *tactical authenticity*—are unique to this paradigm and are intended to create ethically sound, empowering, and beneficial relationships between researchers and their participants. For researchers to act fairly, they need to seek a full range of perspectives across the participant group, including conflicting or contradictory views, and to represent this value pluralism in research reports. Ontological and educative authenticity are optimized by researchers actively contributing to participants' self-understandings as well as their understandings of other stakeholders outside their immediate group. Catalytic and tactical authenticity are judged by the extent to which researchers facilitate participants' roles as change agents within their local context, empowering them to develop their own standards of judgment for evaluating the efficacy of changes to their professional practice. For research designs that draw on both the interpretive and critical paradigms, the authenticity standards can be combined with critical research standards.

Although the trustworthiness and authenticity standards are of fundamental importance to interpretive research, they are not intended to serve as a prescriptive straitjacket for all interpretive research designs. Rather, they should be carefully adapted in accordance with the epistemological nuances and practical feasibility of each study.

Triangulation. Triangulation is a popular standard for mixed-methods research, but it does not necessarily serve the epistemological interests of interpretive researchers. Triangulation is a metaphor drawn from the field of engineering, in which surveyors use multiple (usually two) observation points at either end of a baseline to calculate (via the mathematics of similar triangles) the straight-line distance to a faraway object such as a mountain. In the social sciences, triangulation directs researchers to employ multiple research methods (Mathison, 1988). The classical framing assumption underpinning triangulation is that

multiplicity will help achieve empirical objectivity and inferential certainty. Thus, triangulation is an automatic "weapon of choice" to optimize the validity and reliability of many contemporary mixed-methods research designs, situating them clearly in the post-positivist paradigm.

Jerry Willis (2007) argues that triangulation is not a key quality standard for qualitative research underpinned by a social constructivist epistemology (i.e., interpretive research), especially when seeking to generate deep understandings of participants' complex social realities. Triangulation tends to engage researchers in convergent thinking, that is, seeking confirming evidence (or verification) of the consistency of their participants' meaning-perspectives (i.e., beliefs, perceptions, values) while overlooking the possibility that they might be holding multiple, perhaps contradictory, perspectives. Triangulation also has a tendency to direct researchers to verify their own "etic" (or outsider) perspective rather than uncover the "emic" (or insider) perspective of the culturally different other. This problem has been detected in cultural studies of science education in which simplistic understanding of complex indigenous perspectives is "discovered" by non-indigenous researchers using structured interview protocols based largely on prior (armchair) theorizing (Abrams, Taylor, & Guo, 2013). Michelle Fine is critical of this naïve and disrespectful practice of "Othering," which I take up in the next section on critical research.

Crystallization.   Interpretive research needs to be regulated by standards such as the trustworthiness and authenticity criteria that direct researchers to seek to construct multiple and contingent interpretations of participants' meaning-perspectives. In this context, Laurel Richardson (1994) argues for the metaphor of crystallization that conveys a holistic, multifaceted, and dynamic perspective when compared to the two-dimensional fixity of triangulation (based on plane geometry). Richardson favors the metaphor of the multifaceted crystal (based on light theory) that reflects externalities and refracts within itself, creating a spectrum of dynamic and colorful images. In relation to narrative research writing, crystallization values texts that provide "a deepened, complex, thoroughly partial, understanding of the topic" (p. 934). This is made possible by arts-based research genres discussed in the postmodern research section. So it seems that crystallization rather than triangulation is a better fit for interpretive research when it comes to understanding and representing the complexity of social realities.

Critical Research

Philosophy has evidenced a subversive element from its inception. Plato's Apology tells us how Socrates was condemned by the Athenian citizenry for corrupting the morals of the young and doubting the gods . . . Socrates called conventional wisdom into question. He subjected long-standing beliefs to rational scrutiny and speculated about concerns that projected beyond the existing order.

What became known as "critical theory" was built upon this legacy. . . . Interdisciplinary and uniquely experimental in character, critical theory was always concerned not merely with how things were but how they might be and should be. This ethical imperative led its primary thinkers to develop a cluster of themes and a new critical method that transformed our understanding of society.

(Bronner, 2011, pp. 1, 2)

Critical social theory and research methods entered education via the field of curriculum theorizing in the 1970s/1980s, and science educators began to embrace this approach in the 1990s. Central to the critical research paradigm is a transformative intent to promote social justice, with practitioners acting on the world to make it more democratic, fairer, more equitable, and more inclusive. A critical perspective extends the interpretive researcher's role of understanding the lived experience of the other (*verstehen*) to an advocacy (*praxis*) role of "making a difference."

In the social sciences, critical practitioners employ *ideology critique* to make visible, analyze critically, and transform social structures (normative social practices and their governing policies) that suppress the free will, dignity, and right to self-determination of individuals and minority groups—in other words, the less powerful members of society. Kincheloe (2007) calls this a process of engaging in "critical democracy." Critical practitioners develop a professional praxis for working with socially and/or economically disadvantaged communities. Their transformative goals include fostering a community's social conscience, intellectual prowess, and vision of a brighter future and facilitating the community's critical voice and strategic political skills with which to acquire resources for improving its well-being.

In the field of science education, critical researchers have embraced a range of sociocultural theories imported from the fields of philosophy, anthropology, and sociology. For more than 25 years, science educators have employed critical feminist theory to identify how girls have been disadvantaged historically by "boy-friendly" science instruction and to create gender-inclusive curricula and pedagogies. In the past decade, there has been an upsurge in cultural studies of science education, with critical researchers identifying how "First World" science curricula and research practices transmit a Western modern worldview that excludes and therefore delegitimates the cultural capital of minority and indigenous communities by reproducing a narrow range of cultural values, beliefs, aspirations, languages, and identities (Mutua & Swadener, 2004).

A contemporary focus of critical science educators is development of "socially responsible" science curricula and pedagogies for facilitating students' higher-order critical literacy skills (Taylor, Taylor, & Chow, 2013) for participating in social decision making about the appropriate (ethical) use of science and technology in improving the human condition. Socially responsible science engages

students in critical reflective thinking and critical discourse on contentious issues such as human-induced climate change, genetically modified crops, destruction of ecosystems and loss of biodiversity, and biomedical interventions, among many other issues.

For postgraduate researchers, the critical paradigm provides conceptual tools for ideology critique, self-decolonization, and visionary thinking and supports development of transformative professional practices (or praxes). An *emancipatory* interest (after Habermas; see Young, 1990) fuels the mission of critical researchers to identify and lay bare the hegemony of powerful systems of social thought and action that have colonized historically their societies and continue to maintain a powerful presence by virtue of their invisibility, such as the ideologies of scientism and "crypto-positivism" (Kincheloe & Tobin, 2009) embedded in the Western modern worldview. Adopting a critical epistemology enables postgraduate researchers, especially those from newly independent nations in Africa and Asia with multilingual indigenous populations, to explore ways in which their cultural identities may have been suppressed by culturally insensitive imported curricula, to reconceptualize their cultural identities, values, and aspirations, and to develop transformative philosophies for their future professional practice.

To help avoid hubris—the seductive tendency to occupy the higher moral ground and prescribe how others should change for the better—critical practitioners engage in *critical subjectivity*. While engaging in ideology critique, they turn a critical eye inward and examine their own belief systems, via *critical self-reflection* (or *critical reflexivity*), in order to identify their (perhaps unwitting) complicity in reproducing repressive social structures and power relationships (Brookfield, 1995). The practice of pointing the critical finger ever outward to identify external sources of repression, while insulating from critique one's "revolutionary" values, runs the danger of courting cultural narcissism (Malisa, 2010). The science education community witnessed this process in the early 1990s when constructivist revolutionaries contested established behaviorist psychology, and again, soon after, when advocates of the newly emerging interpretive research paradigm contested advocates of the entrenched classical positivist research paradigm. Both sides engaged in prolonged, impassioned, and critical finger pointing until "paradigm peace" was established, although the rapprochement will become truly universal only when advocates of both sides relinquish their hubris.

To further help avoid the hubris associated with engaging single-mindedly in "win-lose" dualistic thinking, astute critical practitioners employ *dialectical reasoning*. There are numerous forms of dialectical reasoning, but Hegel's *thesis-antithesis-synthesis* has proved to be highly productive (Osborne, 1992). From this perspective, long-standing antinomies, such as individual free will versus conformity to established social norms, are regarded as being complementary (in the sense of mutually presupposing) rather

than mutually annihilating in the way we understand the interaction of matter and antimatter. In order for democratic societies to survive and thrive, it is important that neither individual entitlement nor social responsibility is privileged over the other; both must co-exist, much in the way that we understand light to have both particlelike and wavelike properties. A coherent yet vital democratic society flourishes by means of the creative energy generated by its citizens working productively with the ongoing dialectical tension between competing ideologies.

A number of contemporary qualitative researchers have integrated dialectical thinking into their research perspectives. Michelle Fine (1994) evokes a dialectical perspective when she argues for interpretive researchers to "work the self–other hyphen"; that is, to focus self-consciously on the relationship between the researcher (self) and his/her participant (other) rather than on either one alone, thereby maintaining critical awareness of the process of achieving mutual understanding: "When we construct texts collaboratively, self-consciously examining our relations with/for/despite those who have been contained as Others, we move against, we enable resistance to, Othering . . . Our work will never 'arrive' but must always struggle 'between'" (pp. 74, 75). Wolff-Michael Roth (2005) signifies the dialectical relationship between the individual and society by use of the slash ("/") in the term "auto/ethnography" and argues for "auto/ethnography" as a critical method for science educators to engage in research that critically explores cultural practices, values, and beliefs through the lens of the life history of individuals embedded in those cultures. Steinar Kvale (1996) has developed a dialectical approach to qualitative interviewing, an approach that dispenses with the classical interview method of searching for interpretive coherence in participants' meaning-perspectives and focuses instead on revealing and responding to the contradictions in their everyday lives. According to Kvale, "If social reality is in itself contradictory, the task of social science is to investigate the real contradictions of the social situation and posit them against each other" (p. 57). Dialectical thought is concerned also with new developments in the social world, not only with being but also with becoming, thereby fostering an action orientation toward changing the world—or as critical theorists call it, with praxis.

Critical practitioners maintain a critical awareness of the ever-present danger of the dialectic collapsing into a seductive singularity that resolves naively the tension in people's lives. In examining the dialectic between the dominant ideological press for social conformity and the resistant struggle for individual freedom, it can be tempting to abandon the emancipatory struggle in favor of complacency or cynicism. The challenging task for the critical practitioner, therefore, is to help maintain opportunities for dialectical thought and critical discourse associated with social change. In this regard, critical theorists are contributing to growing disquiet worldwide about the

neoconservative political agenda that is reasserting the positivist research imperative (Denzin & Giardina, 2006).

Quality Standards for Critical Research

For the interpretive research paradigm, I outlined two important sets of quality standards—trustworthiness and authenticity—which support a social constructivist epistemology. Guba and Lincoln (1989) designed these (epistemic and ethical) criteria to ensure that interpretive researchers seek to establish and maintain relationships of mutual understanding and mutual benefit with their participants. The authenticity criteria are applicable also as quality standards for regulating the emancipatory work of critical researchers, ensuring that they avoid hubris and engage in *mutually empowering* relationships with their participants.

In summary, the following quality standards serve to regulate critical research and its reporting, ensuring that critical research practitioners sustain a transformative intent to establish educational policies and practices that enshrine an emancipatory interest in improving the human condition.

Ideology critique. Does the text express a critical perspective on the dominant ideologies that frame social norms and police normative social practices associated with educational policy and/or practice?

Critical subjectivity. Does the author demonstrate critical awareness of her/his own cultural history, explicate the contradictions that beset her/his professional life, and examine critically and insightfully her/his own complicity in its uncritical reproduction in the context of his/her professional practice?

Authentic relationships. Does the author demonstrate an educative relationship with his/her research participants that seeks to foster their development of critical consciousness and empowers them, in the context of their professional roles, as agents of social and cultural reconstruction?

Vision. Does the author articulate a vision for more socially just, equitable, and/or inclusive professional policies and/or practices?

Postmodern Research

> Postmodern knowledge is not simply a tool of the authorities; it refines our sensitivity to differences and reinforces our ability to tolerate the incommensurable. Its principle is not the expert's homology, but the inventor's paralogy.
>
> (Lyotard, 2004, p. xxv)

> The postmodern and postexperimental moments were defined in part by a concern for literary and rhetorical tropes and the narrative turn, a concern for storytelling, for composing ethnographies in new ways . . . this moment

> was shaped by a new sensibility, by doubt, by a refusal to privilege any method or theory . . . researchers continued to move away from foundational and quasi-foundational criteria . . . [toward] criteria that might prove evocative, moral, critical, and rooted in local understandings.
>
> (Denzin & Lincoln, 2005b, p. 3)

The 20th century witnessed the unfolding of a postmodern sensibility—the *linguistic* (or *narrative*) *turn*—especially in the arts. The literary turn was due in large part to continental philosophers such as Michel Foucault, Jacques Derrida, and Jean-Francois Lyotard. Foucault made explicit the largely hidden relationship between power and knowledge, exposing ways in which the individual mind (and thus one's social identity) is controlled by the official discourses of institutions that define the meaning of concepts such as reason and normality. He argued that these concepts should be understood not as stable and inevitable but as contingent and mutable, changing over time according to the needs of authority to control and regulate the behavior of the individual (Stokes, 2002). For the oppressed to gain power involves resisting having one's lifeworld colonized (unwittingly) by the sociocultural norms that inhere in the official discourse of the powerful other. Derrida deconstructed the structuralist myth of the fixed meaning of terms (or signifiers) in language, arguing that languages (including scientific discourse and mathematical symbol systems) are cultural systems of representation rather than deliverers of a single authoritative truth about the world (the signified). Language is differential rather than referential (Belsey, 2002).

Lyotard (2004) argued that, given the postmodern condition of postindustrial societies, the tradition of using "grand narratives" to legitimate social knowledge as overarching (or secure) truth is no longer tenable. Grand narratives (or metanarratives) comprise philosophies of history, or totalizing ideologies (or paradigms), that prescribe ethical, epistemological, and political means of legitimating knowledge production and regulating social decision-making (consensus forming) processes, driven by the seductive modernist worldview of progressively liberating humanity. They range from the emancipatory goal of neo–Marxism favored by critical social theorists to the aspirations of positivist science (or scientism) favored by many science education researchers. Lyotard's postmodern sensibility rejects the grand narrative status of all paradigms, including post-positivism, interpretivism, and criticalism (and postmodernism!): "Simplifying to the extreme, I define *postmodern* as incredulity toward metanarratives" (Lyotard, 2004, p. xxiv).

Of particular relevance to science education is Lyotard's consideration of quantum theory, fractal geometry (Mandelbrot), meta-mathematics (Godel's Incompleteness Theorem), catastrophe theory (Rene Thom), and game theory (Rapoport). He concludes that the legitimacy of knowledge generated by these forms of "postmodern science" relies not on the classical realist correspondence theory of truth, in which a perfect match is sought between

nature and knowledge, but by *paralogy*. Paralogy constitutes deferring consensus (or seeking dissensus) by focusing one's inquiry on the unintelligible, counterexamples, undecidables, "fracta," conflicts of incompleteness, instabilities, anomalies, paradox, and irony and with "new rules in the games of reasoning" (Lyotard, 2004, p. 54). Lyotard draws on Wittgenstein's notion of "language games" to argue that postmodern science and narrative inquiry share the goal of searching for imaginative new insights, that this is achieved by practicing locally determined (but distinctly different) rules of reasoning, and that both tell stories in the form of "little narratives." Postmodernism promotes plurality of language games and directs incredulity at the imperialism of positivist science's claim to a privileged status in the academy.

A postmodern sensibility arose from the dissolution of the "two cultures" dichotomy separating art and science that had been perpetuated by the positivist paradigm (Snow, 1993). In the social sciences, this dissolution came to be known as the *blurred genres moment* (Denzin & Lincoln, 1994), bringing a literary look and feel to social science research, especially a focus on "developing experimental voices that expand the range of narrative strategies" (Tierney & Lincoln, 1997, p. x). The blurred genres moment is characterized by an "ideology of doubt" associated with the Derridean *crisis of representation*, which states that rather than lived experience being captured by the researcher's text, "it is created in the social text written by the researcher" (p. 11); "language produces meaning, creates social reality" (Richardson, 1994, p. 518). Central to this is the issue of voice.

Thanks to the literary turn, social science researchers have access to new literary genres such as *creative nonfiction* (Barone, 2008), *literary tales* (van Maanen, 1988), *poetic inquiry* (Prendergast, Leggo, & Sameshima, 2009), *blogs* (Runte, 2008), and *literary fiction* (Banks, 2008). In post-positivist research, writing is restricted to the classical realist genre that prescribes an objective (authorless) voice set in the past tense. In stark contrast, the multiplicity of voices expressed artfully by literary genres enhances the rhetorical power and transparency of research, greatly enriching the process of research writing as "a method of inquiry" (van Manen, 1990; Richardson, 1994).

Writing as inquiry involves generating qualitative "data texts" of lived experience. These narrative constructions embody the researcher's *ethnographic impulse* to understand deeply the other's lifeworld experience made accessible by postmodern "interviewing," which takes the form of dialogue (Gubrium & Holstein, 2003). In contrast to the semiclinical interview practices of post-positivism, the traditional boundary between interviewers and interviewees is blurred in postmodern research as both parties engage collaboratively in "good conversations," which Steiner Kvale (1996) has playfully labeled "InterViews" and which Mary Gergen (2004) recognizes as "joint constructions." Narrative constructions embody also the researcher's *auto/ethnographic impulse* to "self-dialogue"

as a means of excavating, reimagining, and reconstructing her/his culturally storied identity (Ellis, 2004). The role of imagination in reconstructing identity in narrative inquiry is explored by Theodore Sarbin (2004) and Cynthia Lightfoot (2004).

Denzin and Lincoln (2005b) describe the contemporary qualitative researcher responding to the literary turn in the "postmodern and postexperimental moment" as a *bricoleur* concerned with the aesthetics of representation as s/he stitches together narratives, stories, poems, screenplays, and the like into meaningful and significant "montages" (or wholes). For Clandinin and Connelly (2000), in narrative research, qualitative data texts (arising from fieldwork) are subjected to narrative analysis to produce research texts, a creative writing process that involves achieving balance between "authorial voice," "signature," and "audience." Donald Polkinghorne (1997) draws on Ricoeur and Bourdieu to make a case for "diachronic" research reports that portray narratively the temporal sequence of events comprising research as unfolding human action and experience. The sequencing is carefully "configured" and "smoothed" as a narrative discourse in the form of a story with a plot told by multiple voices: "In a narrative research report, researchers speak with the voice of the storyteller . . . in the first person as the teller of their own tale. Stories are told to (written for) audiences . . . The voices of the subjects who participated in the research are allowed to speak" (pp. 15–16).

Literary genres embody rationalities (or "rules of reasoning") distinctly different from the "pure cold logic" of the Cartesian/Newtonian mechanistic "regime of reason" (Pinar, 1997). One such alternative is a compelling counter-narrative proposed by Joe Kincheloe and Shirley Steinberg (1993). Drawing on physicist-philosopher David Bohm's concept of the "implicate order" of nature, consciousness, and society (Bohm & Peat, 1987), Kincheloe and Steinberg outline a system of *post-formal thinking* that comprises metaphoric, critical, reflective, dialectic, deconstructive, imaginative, relational, spiritual, emotional, holistic, and place-based modes of thinking/being/acting. Post-formal thinking is sensitive to the dynamic, indeterminate, nonlinear, and self-transformative nature of complex living and social systems that characterize education (Davis & Sumara, 2006). In contemporary qualitative research, post-formal thinking embedded in literary genres enables researchers to explore aesthetic and emotional aspects of lived experience and construct narratives that illustrate the complexity, contingency, and emergence of social realities (Barone & Eisner, 2012).

Increasing interest in aesthetics has accelerated the expansion of *arts-based research*, an emerging field engaging contemporary social science researchers across the disciplines. Eliot Eisner (2008) explains the unique contribution of the arts to the production of knowledge in social science research: "Through art we come to feel, very often, what we cannot see directly" (p. 8); "The arts are a way of enriching our awareness and expanding our

humanity" (p. 11). The *Handbook of the Arts in Qualitative Research* (Knowles & Cole, 2008) presents a collection of new genres—*literary forms*, *performance*, *visual art*, *new media*, *folk art*, and *popular art forms*—for enhancing artful representations of the process and outcomes of social science research into the human condition. Among the nondiscursive categories are visual images, dance, music, painting, and photographs. The arts have added an expressive dimension to social science research, giving rise to arts-based (educational) research approaches such as *performance ethnography* (Denzin, 2003), *evocative auto/ethnography* (Ellis, 1997), *testimonio* (Beverley, 2000), *life writing* (Smith, 1994), *ethnodrama* and *ethnotheatre* (Saldana, 2008), and *reader's theatre* (Donmoyer & Donmoyer, 2008), among many others.

Quality Standards for Postmodern Research

Postmodern social science research is a diverse and moving target with a key concern to promote pluralism and deconstruct imperialism, especially the imperialism of the classic validity standards associated with the objectivist epistemology of the positivist paradigm (Lincoln & Denzin, 1994). There is a range of quality standards for regulating writing as inquiry. Here is what some of the leading exponents of postmodern research recommend.

Authorial voice. John van Maanen (1988) argues for postmodern ethnographers to expand the range of their authorial voices beyond classical realism by adopting the literary genres of confessional and impressionistic writing, drawing on literary standards of narrative rationality such as plausibility and verisimilitude (see below). Writing should avoid the conceit of both positivism and solipsism and be judged in terms of its interest, coherence, and fidelity. The following literary devices are offered for writing impressionistic tales: textual identity, fragmented knowledge, characterization, and dramatic control (see also Taylor, 2002).

Verisimilitude. This literary standard is based on the classic French theatrical concept of *vraisemblance* and has been taken to mean that an "authentic" text draws readers into the lifeworlds of its characters because it corresponds with what readers recognize from their own experiences (Adler & Adler, 1994). For Ellis (2004), auto/ethnographic texts achieve verisimilitude inasmuch as they evoke "a feeling that the experience described is lifelike, believable, and possible" (p. 124), with the goal of broadening the researcher's and reader's perspectives, helping them understand empathically the different other and thus overcome their own self-absorption.

Pedagogical thoughtfulness. Max van Manen (1991) argues for writing that engages both researcher and reader in reflecting critically on their values and beliefs about teaching and learning in order to develop "pedagogical thoughtfulness [which] is a multifaceted and complex mindfulness toward children . . . Such pedagogical text needs to possess an inspirational quality together with a narrative structure that invites critical reflection and possibilities for insight that leads to a personal appropriation of a moral intuition" (pp. 8, 9). In developing his postmodern human science approach of "hermeneutic-phenomenology," van Manen (1990) argues that in order to engage the reader in pedagogical thoughtfulness, research writing needs to be "oriented," "strong," "rich," and "deep" if it is to display a dialogical quality.

Performative criteria. A special issue of the journal *Qualitative Inquiry* (June 2000) contains a set of articles by leading practitioner-theorists of postmodern experimental writing in which they discuss criteria for judging the quality of postmodern research writing. Denzin (2003) draws on the literary and aesthetic criteria of Carolyn Ellis, Art Bochner, and Laurel Richardson and the cultural criticism of Patricia Clough to outline a set of seven performative criteria. He values auto/ethnographic texts that "(1) unsettle, criticize, and challenge taken-for-granted, repressed meanings; (2) invite moral and ethical dialogue while reflexively clarifying their own moral positions; (3) engender resistance and offer utopian thoughts about how things can be made different; (4) demonstrate that they care, that they are kind; (5) show instead of tell, using the rule that less is more; (6) exhibit interpretive sufficiency, representational adequacy, and authentic adequacy; and (7) present political, functional, collective, and committed viewpoints" (pp. 123–124). Theoretical discussion combined with practical examples of these criteria in action can be found in Denzin and Giardina's (2008) book on the politics of evidence and Denzin's (1997) book on interpretive ethnography for the 21st century.

Integral Research

> That science is value-free is a myth, and I think that when we realize that this is the case, we do better science . . . We need to blend scientific data (what I call "science sense") with intuition, common sense, indigenous knowledge, and qualitative research, as we try to comprehend the world in which we're immersed.
>
> (Bekoff, 2009)

In the introduction to this chapter, I argued that the transformative potential of qualitative research is yet to be fully realized by science educators due to their traditional affiliation to positivism, the "mother ship" of traditional science education. Too often we resolve this conflict of interest by importing qualitative research methods into post-positivist research designs, thereby privileging the so-called gold standard of objectivity. There is a danger that such mixed-methods research designs breed epistemic blindness among novice researchers that prevents them from expanding the boundaries of science education beyond the confines of the traditional Cartesian/Newtonian worldview.

The four-paradigm taxonomy commonplace in advanced educational research textbooks—*post-positivism*, *interpretivism*, *criticalism*, *postmodernism*—provides a helpful structure for understanding important fundamental differences between quantitative research and qualitative research, differences that are grounded in paradigmatic ways of knowing, being, representing, and valuing rather than (simplistically) in contrasting types of data or methods of collection/analysis. This structure also helps us understand the broad scope of contemporary qualitative research with its interdisciplinary origins in the arts and humanities. However, this structure is not without challenge. How can we justify mixing and matching contrasting epistemologies, especially from the so-called qualitative and quantitative paradigms, given that the philosopher Thomas Kuhn (1962) defined paradigms as intrinsically incommensurable worldviews? The justification needs to be more profound than is allowed for by the simple assertion that it is pragmatically feasible.

Postmodern thinking provides us with a helpful way out of this impasse by pointing out that dualistic "either/or" reasoning is not the only or best way of creating coherent systems of thought. A fundamental problem with dualistic reasoning is its tendency to make us think in terms of binary opposites and to treat these oppositional categories as mutually exclusive, resulting in win-lose discrimination based on, for example, gender (masculine/feminine), ethnicity (White/Black), social class (rich/poor), or body shape (fat/lean)—and, in the case of educational research, paradigm preference. As I have discussed, numerous modes of reasoning are available to us, including post-formal thinking, for which there is a precedent in the physical sciences in the form of dialectical reasoning about the nature of light (i.e., the visible part of the electromagnetic spectrum), allowing for the tension-filled co-existence of the oppositional metaphors of light as particles and light as waves.

For the purpose of my current argument, I shall make use of an inclusive mode of reasoning, *vision-logic*, as discussed recently by the evolutionary philosopher Ken Wilber (1999). Vision-logic draws on Western and Eastern wisdom traditions, seeking to integrate matter, mind, and spirit to generate a holistic understanding of ourselves and our connectedness to one another and to the planet that sustains us. From a vision-logic perspective, each of the paradigms comprising the current taxonomy of educational research is an integral part of a larger system, called the *integral paradigm*. The integral paradigm values absolutely the unique contribution of each and every paradigm (none is privileged) to our ultimate endeavor as educational researchers to help create curricula policies and pedagogical practices that prepare future generations for a world in growing need of its living and nonliving inhabitants being treated with ethical sensitivity (for details, see Taylor, Taylor, & Luitel, 2012). The integral paradigm is already well established in shaping scientific thinking and practice, as evidenced by the recent publication of *Integral Ecology*

(Esbjorn-Hargens & Zimmerman, 2009), a textbook for ecologists and environmentalists inspired by Wilber's integral theory. The authors explain that their book:

> . . . demonstrates that there are numerous approaches to ecology and the environment—philosophical, spiritual, religious, social, political, cultural, behavioural, scientific, and psychological. Each highlights an essential component while ignoring other dimensions. To overcome this fragmentation, *Integral Ecology* provides a way to weave all approaches into an environmental mandala, an ecology of ecologies.
>
> (p. 486)

From an integral research perspective, it is less helpful to distinguish between qualitative and quantitative forms of research and more productive to think holistically about the prospective contribution of multiple research paradigms (from post-positivism to postmodernism), asking *what unique range of research questions can we address by adopting an integral research perspective?* Integral research design is in its infancy, but already graduate students in science education have successfully designed research methodologies that integrate multiple paradigms (e.g., Neumayr & Taylor, 2001; Taylor & Wallace, 2007). By way of illustrating at least one possible approach, the following are synopses of doctoral dissertations that have integrated multiple research paradigms to create *arts-based critical auto/ethnographic research* designs (see also Taylor, 2013).

Exemplar 1

Emilia is a science teacher educator at a university in Mozambique, a multicultural and multilingual Southern African nation that gained political independence from Portugal in 1975. She brought to her doctoral research a concern that science education should enable her country to embrace the modern science and technology of a rapidly globalizing world while not, at the same time, serving a neocolonial agenda of Westernization. Emilia's ambition was to develop a culturally inclusive philosophy of science teacher education that would transform her own professional practice and the practice of science teaching throughout her country. To this end, she designed an arts-based critical auto/ethnography to address two research questions: What are the prospects of creating culturally/inclusive science teacher education in Mozambique, and what obstacles need to be overcome? Her theoretical perspective combined aspects of postcolonial theory, radical constructivism, and holistic curriculum inquiry. As befits interpretive research, another research question emerged during the inquiry: How can I promote good communication in my classes and avoid impediments in communication that reduce my students to the status of things? Emilia's theoretical perspective continued developing with the inclusion of cultural theory, philosophy of science, transformative learning, deep ecology, discourse theory and semiotics, and indigenous knowledge theory.

She employed a range of qualitative research methods to excavate and interrogate her lived experience, including narrative inquiry, autobiography and student testimonials, writing as inquiry and ironic writing, logics of poetry, and metaphor. The diachronic dissertation structure reflects the unfolding process of Emilia's inquiry as she develops a decolonizing eco-pedagogy for science education (for details see Afonso-Nhalevilo, 2010.

Exemplar 2

Yuli Rahmawati is a science teacher educator at an Indonesian university and came to Australia to work on a nationally funded research project on co-teaching and co-generative dialogue in secondary school environmental science. She focused her doctoral research on the development of her own pedagogy, in particular, the emergence of her teaching identity. Yuli designed an arts-based critical auto/ethnography not only to understand deeply her (cultural and religious) teaching self but also to develop as a transformative science educator committed to education for sustainability. She employed a range of qualitative research methods, including narratives of lived experience, stories, informal interview excerpts, vignettes of observed/recalled activities, evocative images, boxed quotes, and poems. This self-study methodology allowed theoretical ideas and questions to emerge and interact throughout the inquiry, including identity theory, philosophy of science, Islamic precepts, and "green" chemistry principles. The dissertation takes the reader on a journey through Yuli's life as she reflects critically on how her teaching identity was shaped by her lived experiences since childhood. The journey continues into the present as she reconceptualizes her teaching identity in relation to her vision as a transformative science teacher educator (for details, see Rahmawati, 2012).

Exemplar 3

Sue Stack brought to her doctoral thesis a unique variety of professional experiences: industrial scientist, sculptor, journalist, and secondary school teacher of science and journalism. She also brought an inquiring mind that had long grappled with the thorny issue of the relationship between science and spirituality, especially in the context of creating an authentic and meaningful science education. For doctoral research, Sue designed an arts-based critical auto/ethnography and employed narrative inquiry; poetic, metaphoric, and fictive genres and images; dialectical reasoning' and transpersonal methods, supplemented by questionnaires, with which she excavated and interrogated her lived experiences, as well as the experiences of colleagues and students. She drew on integral and holistic theories, largely new to science education, to formulate an integral philosophy of science and spirituality, with profound implications for transforming science education. The diachronically structured dissertation evidences an ongoing interaction between emergent research questions and theoretical referents and illustrates Sue's artful engagement in writing as a method of inquiry, taking her reader with her on a deep philosophical journey to reimagine science evolving from modernist to postmodernist to integral science (for details, see Stack, 2006).

Coda

The integral paradigm has opened our doors of perception (Huxley, 1959) to exciting and powerful possibilities for the way we conceive of the interrelationship among the interpretive, critical, and postmodern research paradigms. Already doctoral researchers are occupying this multiparadigmatic research space and are conducting insightful research aimed at transforming science (and mathematics) education policies and practices. Beyond this, the integral paradigm is also challenging us to reconceptualize the relationship between qualitative and quantitative research perspectives. The popular mixed-methods approach has been a good first step in this direction. However, as I have argued, the transformative potential of contemporary qualitative research can be readily blunted by simply importing qualitative methods into post-positivist research designs. The challenge for future researchers is less about how to combine qualitative and quantitative research methods and more about how to integrate the disparate and seemingly conflicting theories of knowing, being, representing, and valuing of multiple paradigms. A key issue for these integral researchers is to ensure that appropriate quality standards are employed to regulate the research methods associated with their parent paradigms.

Acknowledgments

References

Abrams, E., Taylor, P. C., & Guo, C. J. (2013). Contextualizing culturally relevant science and mathematics teaching for indigenous learning. *International Journal of Science and Mathematics Education, 11*(1), 1–21.

Adler, P. A., & Adler, P. (1994). Observational techniques. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 377–392). Thousand Oaks, CA: Sage.

Afonso-Nhalevilo, E. (2010). *Endless journeys: An autoethnographic search for culturally inclusive philosophy of science teacher education in Mozambique.* Saarbruken, Germany: VDM Publishing Group.

Banks, S. (2008). Writing as theory: In defense of fiction. In J. G. Knowles & A. L. Cole (Eds.), *Handbook of the arts in qualitative research* (pp. 155–164). Thousand Oaks, CA: Sage.

Barone, T. (2008). Creative nonfiction and social research. In J.G. Knowles & A.L. Cole (Eds.), *Handbook of the arts in qualitative research* (pp. 105–115). Thousand Oaks, CA: Sage.

Barone, T., & Eisner, E.W. (2012). *Arts based research.* Thousand Oaks, CA: Sage.

Bekoff, M. (2009). Foreword. In S. Esbjorn-Hargens & M. Zimmerman, *Integral ecology: Uniting multiple perspectives on the natural world* (pp. xix–xxxii). Boston, MA: Integral Books.

Belsey, C. (2002). *Poststructuralism: A very short introduction.* New York, NY: Oxford University Press.

Beverley, J. (2000). Testimonio, subalternity, and narrative authority. In N.K. Denzin & Y.S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (2nd ed., pp. 555–565). Thousand Oaks, CA: Sage.

Bohm, D., & Peat, F.D. (1987). *Science, order, and creativity.* New York: Bantam Books.

Bronner, S.E. (2011). *Critical theory: A very short introduction.* New York, NY: Oxford University Press.

Brookfield, S.D. (1995). *Becoming a critically reflective teacher.* San Francisco, CA: Jossey-Bass.

Bryman, A. (2012). *Social research methods* (4th ed.). New York, NY: Oxford University Press.

Carr, W., & Kemmis, S. (1986). *Becoming critical: Education, knowledge and action.* London: Falmer.

Chase, S.E. (2005). Narrative inquiry: Multiple lenses, approaches, voices. In N.K. Denzin & Y.S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (3rd ed., pp. 651–679). Thousand Oaks, CA: Sage.

Clandinin, D.J., & Connelly, F.M. (1994). Personal experience methods. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 413–427). Thousand Oaks, CA: Sage.

Clandinin, D.J., & Connelly, F.M. (2000). *Narrative inquiry: Experience and story in qualitative research.* San Francisco, CA: Jossey-Bass.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education* (7th ed.). Abingdon, OX: Routledge.

Creswell, J.W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Boston, MA: Pearson Education.

Davis, B., & Sumara, D. (2006). *Complexity and education: Inquiries into learning, teaching and research.* Mahwah, NJ: Lawrence Erlbaum.

Denzin, N.K. (1997). *Interpretive ethnography: Ethnographic practices for the 21st century.* Thousand Oaks, CA: Sage Publications.

Denzin, N.K. (2003). *Performance ethnography: Critical pedagogy and the politics of culture.* Thousand Oaks, CA: Sage.

Denzin, N.K., & Giardina, M.D. (Eds.). (2006). *Qualitative inquiry and the conservative challenge.* Walnut Creek, CA: Left Coast Press.

Denzin, N.K., & Giardina, M.D. (Eds.). (2008). *Qualitative inquiry and the politics of evidence.* Walnut Creek, CA: Left Coast Press.

Denzin, N.K., & Lincoln, Y.S. (Eds.). (1994). *Handbook of qualitative research.* Thousand Oaks, CA: Sage.

Denzin, N.K., & Lincoln, Y.S. (2000). Introduction: The discipline and practice of qualitative research. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed., pp. 1–28). Thousand Oaks, CA: Sage.

Denzin, N.K., & Lincoln, Y.S. (Eds.). (2005a). *The SAGE handbook of qualitative research* (3rd ed.). Thousand Oaks, CA: Sage.

Denzin, N.K., & Lincoln, Y.S. (2005b). Introduction: The discipline and practice of qualitative research. In N.K. Denzin & Y.S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (3rd ed., pp. 1–32). Thousand Oaks, CA: Sage.

Donmoyer, R., & Donmoyer, J.Y. (2008). Readers' theatre as a data display strategy. In J.G. Knowles & A.L. Cole (Eds.), *Handbook of the arts in qualitative research* (pp. 209–224). Thousand Oaks, CA: Sage.

Eisenhart, M.A. (1988). The ethnographic research tradition and mathematics education research. *Journal for Research in Mathematics Education, 19*(2), 99–114.

Eisner, E. (2008). Art and knowledge. In J.G. Knowles & A.L. Cole (Eds.), *Handbook of the arts in qualitative research* (pp. 3–12). Thousand Oaks, CA: Sage.

Ellis, C. (1997). Evocative autoethnography: Writing emotionally about our lives. In W.G. Tierney & Y.S. Lincoln (Eds.), *Representation and the text: Re-framing the narrative voice* (pp. 115–139). Albany: State University of New York Press.

Ellis, C. (2004). *The ethnographic I: A methodological novel about auto-ethnography.* Walnut Creek, CA: Altamira Press.

Erickson, F. (1986). Qualitative methods in research on teaching. In M.C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed., pp. 119–159). New York, NY: Macmillan.

Esbjorn-Hargens, S., & Zimmerman, M.E. (2009). *Integral ecology: Uniting multiple perspectives on the natural world.* Boston, MA: Integral Books.

Fine, M. (1994). Working the hyphens: Reinventing self and other in qualitative research. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 70–82). Thousand Oaks, CA: Sage.

Gallagher, J.J. (Ed.). (1991). *Interpretive research in science education.* NARST Monograph, No 4. National Association for Research in Science Teaching. Manhattan, KS: Kansas State University.

Gergen, M. (2004). Once upon a time: A narratologist's tale. In C. Daiute & C. Lightfoot (Eds.), *Narrative analysis: Studying the development of individuals in society* (pp. 267–285). Thousand Oaks, CA: Sage.

Goswami, A. (1993). *The self-aware universe: How consciousness creates the material world.* New York, NY: Tarcher/Putnam/Penguin.

Green, J.L., Camilli, G., & Elmore, P.B. (Eds.). (2006). *Handbook of complementary methods in education research.* Mahwah, NJ: Lawrence Erlbaum.

Guba, E.G. (1990). The alternative paradigm dialog. In E.G. Guba (Ed.), *The paradigm dialog* (pp. 17–27). Newbury Park, CA: Sage Publications.

Guba, E.G., & Lincoln, Y.S. (1988). Naturalistic and rationalistic enquiry. In J.P. Keeves (Ed.), *Educational research, methodology, and measurement: An international handbook* (pp. 81–85). Sydney, Australia: Pergamon Press.

Guba, E.G., & Lincoln, Y.S. (1989). *Fourth generation evaluation.* Newbury Park, CA: Sage.

Guba, E.G., & Lincoln, Y.S. (1994). Competing paradigms in qualitative research. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105–117). Thousand Oaks, CA: Sage.

Guba, E.G., & Lincoln, Y.S. (2005). Paradigmatic controversies, contradictions, and emerging confluences. In N.K. Denzin & Y.S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (3rd ed., pp. 191–215). Thousand Oaks, CA: Sage.

Gubrium, J.F., & Holstein, J.A. (2003). *Postmodern interviewing.* Thousand Oaks, CA: Sage.

Haarman, H. (2007). *Foundations of culture: Knowledge-construction, belief systems and worldview in their dynamic interplay.* Frankfurt, Germany: Peter Lang.

Habermas, J. (1972). *Knowledge and human interests* (J.J. Shapiro, Trans.). London: Heinemann.

Hamilton, D. (1977). *Beyond the numbers game: A reader in educational evaluation.* Basingstoke, UK: Macmillan.

Hamilton, D. (1994). Traditions, preferences, and postures in applied qualitative research. In N.K. Denzin, & Y.S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 60–69). Thousand Oaks, CA: Sage.

Howell, K.E. (2013). *An introduction to the philosophy of methodology.* London: Sage.

House, E.R. (2006). Methodological fundamentalism and the quest for control(s). In N.K. Denzin & M.D. Giardina (Eds.), *Qualitative inquiry and the conservative challenge* (pp. 93–108). Walnut Creek, CA: Left Coast Press.

Huxley, A. (1959). *The doors of perception and heaven and hell.* New York, NY: Bantam Books.

Janesick, V.J. (1994). The dance of qualitative research design. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 209–219). Thousand Oaks, CA: Sage.

Kincheloe, J.L. (2007). Critical pedagogy in the twenty-first century. In P. McLaren & J.L. Kincheloe (Eds.), *Critical pedagogy: Where are we now?* (pp. 9–42). New York, NY: Peter Lang.

Kincheloe, J.L., & Steinberg, S.R. (1993). A tentative description of post-formal thinking: The critical confrontation with cognitive thinking. *Harvard Educational Review, 63,* 296–320.

Kincheloe, J., & Tobin, K. (2009). The much exaggerated death of positivism. *Cultural Studies of Science Education, 4,* 513–528.

Knowles, J.G., & Cole, A.L. (Eds.). (2008). *Handbook of the arts in qualitative research.* Thousand Oaks, CA: Sage.

Kuhn, T.S. (1962). *The structure of scientific revolutions.* Chicago: University of Chicago Press.

Kvale, S. (1996). *InterViews: An introduction to qualitative research interviewing.* Thousand Oaks, CA: Sage.

Lassonde, C.A., Galman, S., & Kosnik, C. (Eds.). (2009). *Self-study research for teacher educators.* Rotterdam, the Netherlands: Sense Publishers.

Lightfoot, C. (2004). Fantastic self: A study of adolescents' fictional narratives, and aesthetic activity as identity work. In C. Daiute & C. Lightfoot (Eds.), *Narrative analysis: Studying the development of individuals in society* (pp. 21–37). Thousand Oaks, CA: Sage.

Lincoln, Y.S. (2005). Institutional review boards and methodological conservatism: The challenge to and from phenomenological paradigms. In N.K. Denzin & Y.S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (3rd ed., pp. 165–181). Thousand Oaks, CA: Sage.

Lincoln, Y.S. (2009). "What a long, strange trip it's been . . ." Twenty-five years of qualitative and new paradigm research. *Qualitative Inquiry, 16*(1), 3–9.

Lincoln, Y.S., & Denzin, N.K. (1994). The fifth moment. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 575–586). Thousand Oaks, CA: Sage.

Lyotard, J.F. (2004). *The postmodern condition: A report on knowledge* (G. Bennington & B. Massumi, Trans.). Minneapolis: University of Minnesota Press. (Original work published 1979)

Malisa, M. (2010). *(Anti) narcissisms and (anti) capitalisms: Human nature and education in the works of Mahatma Gandhi, Malcolm X, Nelson Mandela and Jurgen Habermas.* Rotterdam, the Netherlands: Sense publishers.

Mathison, S. (1988). Why triangulate? *Educational Researcher*, *17,* 13–17.

McNiff, J., & Whitehead, J. (2011). *All you need to know about action research* (2nd ed.). Thousand Oaks, CA: Sage.

Mutua, K., & Swadener, B.B. (Eds.). (2004). *Decolonizing research in cross-cultural contexts: Critical personal narratives.* Albany, NY: State University of New York Press.

Neumayr, E., & Taylor, P.C. (2001). A cosy bedding for science education research? Ken Wilber's integral philosophy. In S. Gunn & A. Begg (Eds.), *Mind, body & society: Emerging understandings of knowing and learning* (pp. 109–116). Melbourne, Australia: Department of Mathematics and Statistics, University of Melbourne.

Nhalevilo, E.Z. de F. (2013). Rethinking the history of inclusion of IKS in school curricula: Endeavouring to legitimate the subject. *International Journal of Science and Mathematics Education, 11*(1), 23–42.

Osborne, R. (1992). *Philosophy for beginners.* New York, NY: Writers and Readers Publishing.

Paul, J.L., & Marfo, K. (2001). Preparation of educational researchers in philosophical foundations of inquiry. *Review of Educational Research, 71,* 525–547.

Pinar, W.F. (1997). Regimes of reason and the male narrative voice. In W.G. Tierney & Y.S. Lincoln (Eds.), *Representation and the text: Re-framing the narrative voice* (pp. 82–113). Albany: State University of New York Press.

Pithouse, K., Mitchell, C., & Moletsane, R. (Eds.). (2010). *Making connections: Self-study & social action.* New York, NY: Peter Lang.

Polkinghorne, D.E. (1997). Reporting qualitative research as practice. In W.G. Tierney & Y.S. Lincoln (Eds.), *Representation and the text: Re-framing the narrative voice* (pp. 3–21). Albany: State University of New York Press.

Prendergast, M., Leggo, C., & Sameshima, P. (Eds.). (2009). *Poetic inquiry: Vibrant voices in the social sciences.* Rotterdam, the Netherlands: Sense Publishers.

Rahmawati, Y. (2012). *Revealing and reconceptualising teaching identity through the landscapes of culture, religion, transformative learning, and sustainability education: A transformation journey of a science educator* (Doctoral thesis, Curtin University, Perth, Australia). Retrieved from http://espace.library.curtin.edu.au

Reason, P., & Bradbury, H. (2001). Introduction: Inquiry and participation in search of a world worthy of human aspiration. In P. Reason & H. Bradbury (Eds.), *Handbook of action research: Participative inquiry and practice* (pp. 1–14). Thousand Oaks, CA: Sage Publications.

Reed-Danahay, D.E. (Ed.). (1997). *Auto/ethnography: Rewriting the self and the social.* Oxford, UK: Berg.

Richardson, L. (1994). Writing: A method of inquiry. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 516–529). Thousand Oaks, CA: Sage.

Rossenblum, B., & Kuttner, F. (2011). *Quantum enigma: Physics encounters consciousness* (2nd ed.). New York, NY: Oxford University Press.

Roth, W.-M. (Ed.). (2005). *Auto/biography and auto/ethnography: Praxis of research method.* Rotterdam, the Netherlands: Sense Publishers.

Runte, R. (2008). Blogs. In J.G. Knowles & A.L. Cole (Eds.), *Handbook of the arts in qualitative research* (pp. 299–312). Thousand Oaks, CA: Sage.

Saldana, J. (2008). Ethnodrama and ethnotheatre. In J.G. Knowles & A.L. Cole (Eds.), *Handbook of the arts in qualitative research* (pp. 195–207). Thousand Oaks, CA: Sage.

Sarbin, T. (2004). The role of the imagination in narrative construction. In C. Daiute & C. Lightfoot (Eds.), *Narrative analysis: Studying the development of individuals in society* (pp. 5–20). Thousand Oaks, CA: Sage.

Schon, D.A. (1983). *The reflective practitioner: How professionals think in action.* New York, NY: Basic Books.

Schwandt, T.A. (2001). *Dictionary of qualitative inquiry* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Simons, H. (Ed.). (1980). *Towards a science of the singular.* Norwich, UK: University of East Anglia, Centre for Applied Research in Education.

Smith, D.G. (2008). From Leo Strauss to collapse theory: Considering the neoconservative attack on modernity and the work of education. *Critical Studies in Education, 49*(1), 33–48.

Smith, L. (1994). Biographical method. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 286–305). Thousand Oaks, CA: Sage.

Snow, C.P. (1993). *Two cultures and the scientific revolution.* London, NY: Cambridge University Press.

Stack, S.J. (2006). *Integrating science and soul in education: The lived experience of a science teacher bringing holistic and integral perspectives to the transformation of science teaching* (Doctoral thesis, Curtin University of Technology, Perth, Australia). Retrieved from http://espace.library.curtin.edu.au

Stokes, P. (2002). *Philosophy: 100 essential thinkers.* London: Arcturus Publishing.

Taylor, E., Taylor, P.C., & Chow M.L. (2013). Diverse, disengaged and reactive: A teacher's adaptation of ethical dilemma story pedagogy as a strategy to re-engage learners in education for sustainability. In N. Mansour & R. Wegerif (Eds.), *Science education for diversity: Theory and practice* (pp. 97–117). Rotterdam, the Netherlands: Sense Publishers.

Taylor, P.C. (2002). On being impressed by college teaching. In P.C. Taylor, P.J. Gilmer & K. Tobin (Eds.), *Transforming undergraduate science teachin*g (pp. 3–43). New York, NY: Peter Lang.

Taylor, P.C. (2013). Research as transformative learning for meaning-centred professional development. In O. Kovbasyuk & P. Blessinger (Eds.), *Meaning-centred education: International perspectives and explorations in higher education* (pp. 168–185). New York, NY: Routledge.

Taylor, P.C., Gilmer, P.J., & Tobin, K. (Eds.). (2002). *Transforming undergraduate science teaching: Social constructivist perspectives.* New York, NY: Peter Lang Publishing.

Taylor, P.C., & Medina, M.N.D. (2013). Educational research paradigms: From positivism to multiparadigmatic. *Journal for Meaning-Centered*

Education, 1. Retrieved from www.meaningcentered.org/journal/volume-01/educational-research-paradigms-from-positivism-to-multiparadigmatic/

Taylor, P. C., Taylor, E., & Luitel, B.C. (2012). Multi-paradigmatic transformative research as/for teacher education: An integral perspective. In B. J. Fraser, K. G. Tobin, & C. J. McRobbie (Eds.), *Second international handbook of science education* (pp. 373–387). Dordrecht, the Netherlands: Springer.

Taylor, P. C., & Wallace, J. (Eds.). (2007). *Contemporary qualitative research: Exemplars for science and mathematics educators.* Dordrecht, the Netherlands: Springer.

Tierney, W. G., & Lincoln, Y. S. (1997). Introduction: Explorations and discoveries. In W. G. Tierney & Y. S. Lincoln (Eds.), *Representation and the text: Re-framing the narrative voice* (pp. vii–xvi). Albany: State University of New York Press.

Tobin, K. (Ed.). (1993). *The practice of constructivism in science education.* Hillsdale, NJ: Lawrence Erlbaum.

Tuckman, B. W. (1978). *Conducting educational research* (2nd ed.). Chicago, IL: Harcourt Brace Jovanovich.

van Maanen, J. (1988). *Tales of the field: On writing ethnography.* Chicago, IL: University of Chicago Press.

van Manen, M. (1990). *Researching lived experience: Human science for an action sensitive pedagogy.* London, Ontario: State University of New York.

van Manen, M. (1991). *The tact of teaching: The meaning of pedagogical thoughtfulness.* Albany: State University of New York Press.

Walker, R. (1980). The conduct of educational case studies: Ethics, theory and procedures. In W. B. Dockerell & D. Hamilton (Eds.), *Rethinking educational research* (pp. 30–63). London: Hodder and Stoughton.

Wheatley, G. (1991). Constructivist perspectives on science and mathematics learning. *Science Education, 75*(1), 9–21.

Wilber, K. (1999). *The collected works of Ken Wilber: Volume 4.* Boston, MA: Shambhala.

Willis, J. W. (2007). *Foundations of qualitative research: Interpretive and critical approaches.* Thousand Oaks, CA: Sage.

Wolcott, H. (1990). On seeking—and rejecting—validity in qualitative research. In E. W. Eisner & A. Peshkin (Eds.), *Qualitative inquiry in education: The continuing debate* (pp. 121–152). New York, NY: Teachers College Press.

Young, R. (1990). *A critical theory of education: Habermas and our children's future.* New York, NY: Teachers College Press.