

Coda: Novelizing the Novelized Image of Science in Education

In this book, we elaborate—drawing on Bakhtin’s work—the concepts of epicization and novelization to understand two different kinds of cultural processes at work in the imagination of science in education. Epicization describes the tendency toward a unitary language and culture in the teaching of science. This observable tendency manifests underlying forces that work toward concrete verbal and ideological unification and centralization. These forces, in turn, develop a vital connection with the processes of sociopolitical and cultural centralization, mitigating the cultural diversity inherent to development of the natural sciences for which students are supposed to be prepared in science education. By closely studying the tendencies toward a unitary language of science in the representation practices of science education featured in this book, we learn how cultural centralization operates in the discipline’s mundane practices. This allows us to counter unification processes by taking cultural diversity as a norm rather than the exception. Indeed, an emphasis on the latter is the reason that many studies on cultural diversity, along with decreased reflexivity, unwittingly mitigate the very ends that are to be accomplished (Gough 2007).

Our proposal of rethinking of science curricula in terms of the novelization of representation practices of science has both methodological and educational implications of interest to the global community of science education research, practice, and policy. One implication of our study is the need to make thematic the focus on the common and mundane in science curricula—blind spots in the theoretical frameworks of current science education. This allows researchers to avoid the pitfall of stereotyping and naturalizing underrepresented groups through research and, hence, eventually mitigating the very ends that are to be achieved by compounding existing problems arising from common sense understandings. What is more, a closer look at how cultural diversity plays into the common and mundane at the core of science education takes the latter as the norm in this core rather than the exception at its margin. But in such a closer look, we may have to abandon cherished theoretical frameworks, because their blind spots “may remain in the

vision of science educators who are particularly attentive to the cultural contexts of science and science education” (p. 53). Both improvements allow for a better understanding of valuing and keeping cultural diversity in science education.

Another implication follows from rupturing the focus on the decoding side (i.e., on understanding) of science education research concerned with cultural diversity. Accordingly, understanding how the valuing and keeping cultural diversity in science education is mitigated by the exclusion of particular groups of students requires a gaze that goes beyond how these students decode representations in science curricula. One may then find how representations are encoded in science curricula such that they do not allow the novelization of science. There is a body of research on this aspect of encoding in science curricula, focusing, for instance, on the role of graphing in science curricula and how it introduces conceptual blind spots into students’ thinking (e.g., Roth 2001). Attending to this and comparable bodies of literature may yield substantial methodological gains in understanding the valuing and keeping of cultural diversity.

In an increasingly globalized world that proliferates the encounter between different cultures and languages, science curricula must allow students to become competent contributors to democratic novelizing processes. In our more recent research on “authentic” science education, we developed such curricula. We suggest here that novelization of representation practices of science does not lie with the level of agreement between school science and the natural sciences. Indeed, more relevant are the levels of control, authority, mastery, and authorship that students are enabled to exercise in such science curricula—as exhibited in the previously described environmental curriculum (Roth and Lee 2004). These levels are uncommon and imply curricula that unfold dialogically and therefore in unexpected ways, which poses a challenge to traditional approaches that think science education in terms of “scope and sequence.”

Reflexively, unifying processes are at work in science education as a field because the peer review process tends to decrease cultural diversity (e.g., by truncating certain forms of research process and agencies) toward a heavily Anglo-Saxon way of looking at, describing, and theorizing the world of learning science in and out of schools (e.g., Barton 2002). Thus, constructivism is Eurocentric and therefore constitutes a vision of science education that makes our field blind to certain problems arising from globalization, such as implementing the same curricula across (multi-) cultural settings.

We conclude this book with a word of caution. If novelization were to be the name of a form of science education that we aim at and eventually achieve, a new canonical form, then we would have done nothing other than institute the epicization of novelization. This is precisely the warning Carter (2008) has for those who attempt to absolutize traditional ecological knowledge rather than seeing it as one form (strata) of language useful in tackling the “wicked problems” in science education (Carter 2011). As its dialectical (dialogical) inversion, the novelization that is part of the epicization of a new form of science education would be a contradiction in our argument. In fact, Bakhtin recognizes that the novel “fights for its own hegemony in literature” and “wherever it triumphs, the other older genres

go into decline” (p. 4). But hegemony means unitary language, the opposite of novelization. Novelization, to be true to its name, must remain forever uncompleted, a never achievable novelization-to-come. In this strategic move, novelization names a never-ending process. We do so, for “whenever there is a telos or teleology comes to orient, order, and make possible a historicity, it annuls that historicity by the same token and neutralizes the unforeseeable and incalculable irruption, the singular and exceptional alterity of what comes” (Derrida2005, p. 128). This is but another way of expressing dialogic imagination—the title of Bakhtin’s (1981) book—which is inherently open ended, continually developing because in exchange with difference. In the same way as Nancy’s (1993) concept of the *mêlée*, novelization must remain a gesture of culture: “of confrontation transformation, deviation, development, recomposition, combination, cobbling together” (p. 13).

References

- Aikenhead, G. S. (2001). Students' ease in crossing cultural borders into school science. *Science Education*, 85, 180–188.
- Aikenhead, G. S., & Ogawa, M. (2007). Indigenous knowledge and science revisited. *Cultural Studies of Science Education*, 2, 539–620.
- Allchin, D. (2003). Scientific myth-conceptions. *Science Education*, 87, 329–351.
- American Association for the Advancement of Science (AAAS). (1993). *Benchmarks for science literacy*. New York: Oxford University Press.
- Atleo, E. R. (1991). Policy development for museums: A first nations perspective. In D. Jensen & C. Brooks (Eds.), *In celebration of our survival: The first nations of British Columbia* (pp. 48–61). Vancouver: UBC Press.
- Atleo, E. R. (Umeek) (2004). *Tsawalk: A Nuu-chah-nulth worldview*. Vancouver, BC: UBC Press.
- Bakhtin, M. M. (1981). *The dialogic imagination*. Austin: University of Texas Press.
- Bakhtin, M. M. (1984a). *Problems of Dostoevsky's poetics* (C. Emerson, Trans.). Minneapolis: University of Minnesota Press. (Original work published 1972)
- Bakhtin, M. M. (1984b). *Rabelais and his world*. Bloomington: Indiana University Press.
- Bakhtin, M. M. (1993). *Toward a philosophy of the act*. Austin: University of Texas Press.
- Bakhtin, M. M., & Medvedev, P. N. (1978). *The formal method in literary scholarship: A critical introduction to sociological poetics*. Baltimore: Johns Hopkins University Press.
- Bakhtine, M. [Volochinov, V. N.]. (1977). *Le marxisme et la philosophie du langage: essai d'application de la méthode sociologique en linguistique*. Paris: Les Éditions de Minuit.
- Barton, A. C. (2002). Urban science education studies: A commitment to equity, social justice and a sense of place. *Studies in Science Education*, 38, 1–38.
- Barton, A. C. (2009). Mothering and science literacy: Challenging truth-making and authority through counterstory. In W.-M. Roth (Ed.), *Science education from people for people: Taking a stand (point)* (pp. 134–145). New York: Routledge.
- Barwise, J. (1988). On the circumstantial relation between meaning and content. In U. Eco, M. Santambrogio, & P. Violi (Eds.), *Meaning and mental representations* (pp. 23–39). Bloomington: Indiana University Press.
- Basso, K. H. (1996). *Wisdom sits in places. Landscapes and language among the Western Apache*. Albuquerque: University of New Mexico Press.
- Bastide, F. (1985). Iconographie des textes scientifiques: principes d'analyse [The iconography of scientific texts: principles of analysis]. *Culture technique*, 14, 132–151.
- Bateson, G. (1972). *Steps to an ecology of mind: A revolutionary approach to man's understanding of himself*. New York: Ballantine.
- Bergson, H. (1998). *Durée et simultanéité: À propos de la théorie d'Einstein* [Duration and simultaneity: On the theory of Einstein]. Paris: Presses Universitaires de France.

- Blumstein, D. T., & Saylan, C. (2007). The failure of environmental education (and how we can fix it). *PLoS Biology*, 5, 973–977.
- Bourdieu, P. (1980). *Le sens pratique* [Logic of practice]. Paris: Les Éditions de Minuit.
- Bowen, G. M., Roth, W.-M., & McGinn, M. K. (1999). Interpretations of graphs by university biology students and practicing scientists: Towards a social practice view of scientific re-presentation practices. *Journal of Research in Science Teaching*, 36, 1020–1043.
- Brandt, C. B. (2008). Discursive geographies in science: Space, identity, and scientific discourse among indigenous women. *Cultural Studies of Science Education*, 3, 703–730.
- Brandt, C. B. (2009). Faith in a seed: Social memory, local knowledge, and scientific practice. In W.-M. Roth (Ed.), *Science education from people for people: Taking a stand (point)* (pp. 39–53). New York: Routledge.
- Brannon, E.L. (1987). Mechanisms stabilizing salmonid fry emergence timing. Canadian Special Publication of Fisheries and Aquatic Sciences, 96, 120–124.
- Brown, B. (2006). “It isn’t no slang that can be said about this stuff”: Language, identity, and appropriating science discourse. *Journal of Research in Science Teaching*, 43, 96–126.
- Burgner, R.L. (1991). Sockeye salmon. In Groot, C., & Margolis, L., (Eds.) *Pacific Salmon Life Histories* (pp. 3–117). Vancouver, BC: University of British Columbia Press.
- Callon, M. (1991). Techno-economic networks and irreversibility. In J. Law (Ed.), *A sociology of monsters: Essays on power, technology and domination* (pp. 132–165). London: Routledge.
- Callon, M. (2001). Actor network theory. In N. J. Smelser & P. B. Baltes (Eds.), *International encyclopedia of the social and behavioral sciences* (pp. 62–66). Oxford: Elsevier Science.
- Carter, L. (2004). Thinking differently about cultural diversity: Using postcolonial theory to (re)read science. *Science Education*, 88, 819–836
- Carter, L. (2008). Recovering traditional ecological knowledge (TEK): Is it always what it seems. *Transnational Curriculum Inquiry*, 5(1), 17–25.
- Carter, L. (2011). Gathering in threads in the insensible global world: The wicked problem of globalisation and science education. *Cultural Studies of Science Education*, 6, 1–12.
- Chambers, D. W. (1983). Stereotypic images of the scientist: The draw-a-scientist test. *Science Education*, 67, 255–265.
- Collectif Chimie Cégep Limoilou. (1998). *Partageons nos connaissances: des élèves rencontrent la population des quartiers populaires. Guide d’activités scientifiques à l’intention des enseignants et des enseignantes de sciences* [Sharing our knowledge: Students meet the inhabitants of working-class areas. A guide to scientific activities intended for teachers and teachers of science]. Québec, QUE: Collège d’enseignement général et professionnel de Limoilou.
- de Saussure, F. (1916/1995). *Cours de linguistique générale* [Course on general linguistics]. Paris: Payot.
- DeBoer, G. E. (2000). Scientific literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching*, 37, 582–601.
- DeHart Hurd, P. (1958). Science literacy: Its meaning for American schools. *Educational Leadership*, 16, 13–16.
- Derrida, J. (1972). *Marges de la philosophie* [Margins of philosophy]. Paris: Les Éditions de Minuit.
- Derrida, J. (1978). Structure, sign and play in the human sciences (A. Bass, Trans.). In J. Derrida (Ed.), *Writing and difference* (pp. 278–294). London: Routledge.
- Derrida, J. (1981). *Dissemination*. Chicago: University of Chicago Press.
- Derrida, J. (1985). *The ear of the other*. Lincoln, NE: University of Nebraska Press.
- Derrida, J. (1992). *Donner la mort* [Giving death]. Paris: Galilée.
- Derrida, J. (1996). *Le monolinguisme de l’autre ou la prothèse d’origine* [Monolingualism of the other or the prosthesis of origin]. Paris: Galilée.
- Derrida, J. (1998). *Monolingualism of the Other; or, The prosthesis of origin*. Stanford, CA: Stanford University Press.
- Derrida, J. (2005). *Rogues: Two essays on reason* (P.-A. Brault & M. Naas, Trans.). Stanford: Stanford University Press.

- Driver, R., Leach, J., Millar, R., & Scott, P. (1996). *Young people's images of science*. Buckingham: Open University Press.
- Eco, U. (1976). *A theory of semiotics*. Bloomington: Indiana University Press.
- Eco, U. (1984a). *Semiotics and the philosophy of language*. Bloomington: Indiana University Press.
- Eco, U. (1984b). *The name of the rose*. Boston: G. K. Hall.
- Einstein, A. (1931). *Cosmic religion: With other opinions and aphorisms*. New York: Covici-Friede.
- Eisenhart, M., Finkel, E., & Marion, S. (1996). Creating the conditions for scientific literacy: A re-examination. *American Educational Research Journal*, 33, 261–295.
- Elliott, D. Sr. (1983). Saltwater People. Central Saanich, BC: School District No. 63.
- Emad, G., & Roth, W.-M. (2008). Contradictions in practices of training for and assessment of competency: A case study from the maritime domain. *Education and Training*, 50, 260–272.
- Fensham, P. (2002). Time to change drivers for scientific literacy. *Canadian Journal of Science, Mathematics, and Technology Education*, 2, 9–24.
- Forsee, A. (1963). *Albert Einstein: Theoretical physicist*. New York: Macmillan.
- Foucault, M. (1975). *Surveiller et punir: Naissance de la prison* [Discipline and punish: The birth of the prison]. Paris: Gallimard.
- Foucault, M. (1979b). Truth and power. In Morris, M. and Patton, P. (Eds.) *Power, Truth, Strategy* (pp. 29–48). Sydney: Feral Publications.
- Gaskell, J. (2003). Engaging science education within diverse cultures. *Curriculum Inquiry*, 33, 235–249.
- Gott, R., & Duggan, S. (2007). A framework for practical work in science and scientific literacy through argumentation. *Research in Science and Technological Education*, 25, 271–291.
- Gough, N. (2007). All around the world science education, constructivism, and globalization. In B. Atweh, A. C. Barton, M. Borba, N. Gough, C. Keitel, C. Vistro-Yu, & R. Vithal (Eds.), *Internationalisation and globalization in mathematics and science education* (pp. 39–55). Dordrecht: Springer.
- Gruenewald, D. A. (2003). The best of both worlds: A critical pedagogy of place. *Educational Researcher*, 32(4), 3–12.
- Haggan, N., Turner, N.J., Carpenter, J., Jones, J.T., Menzies, C., & Mackie, Q. (2006). 12,000+ Years of Change: Linking Traditional and Modern Ecosystem Science in The Pacific Northwest, Working Paper 2006–02. Vancouver, BC: University of British Columbia Fisheries Centre.
- Hall, S. (1980). Hall, S. Encoding/decoding. In S. Hall, D. Hobson, A. Lowe, & P. Willis (Eds.) *Culture, Media, Language* (pp. 128–138). London: Hutchinson.
- Hall, S. (1990). Cultural identity and diaspora. In J. Rutherford (Ed.), *Identity: Community, culture, difference* (pp. 222–237). London: Lawrence & Wishart.
- Hamilton, R. (1991). Our voice—our struggle. In D. Jensen & C. Brooks (Eds.), *In celebration of our survival: The First Nations of British Columbia* (p. 7). (Vancouver, BC: UBC Press).
- Han, J., & Roth, W.-M. (2006). Chemical inscriptions in Korean textbooks: Semiotics of macro- and microworld. *Science Education*, 90, 173–201.
- Haymes, S. (1995). *Race, culture and the city: A pedagogy for Black urban struggle*. Albany: State University of New York Press.
- Hazen, R. M., & Trefil, J. (1990). *Science matters: Achieving scientific literacy*. New York: Doubleday.
- Hazen, R. M., & Trefil, J. S. (1992). *Science Matters: Achieving scientific literacy*. New York: Anchor.
- Heidegger, M. (1971). *Poetry, language, thought* (A. Hofstadter, Trans.). New York: Harper & Row.
- Heidegger, M. (1977). *Sein und Zeit* [Being and time]. Tübingen: Max Niemeyer.
- Heidegger, M. (1996). *Being and time* (J. Stambaugh, Trans.). Albany: State University of New York Press.

- Hendry, A.P. (2001). Adaptive divergence and the evolution of reproductive isolation in the wild: an empirical demonstration using introduced sockeye salmon. *Genetica*, 112–113, 515–534.
- Henry, M. (2000). *Incarnation: Une philosophie de la chair* [Incarnation: A philosophy of the flesh]. Paris: Seuil.
- Hodson, D. (1999). Going beyond cultural pluralism: Science education for sociopolitical action. *Science Education*, 83, 775–796.
- Holzkamp, K. (1993). *Lernen: Subjektwissenschaftliche Grundlagen* [Learning: Subject-scientific foundations]. Frankfurt: Campus-Verlag.
- Hutchins, E. (1995). *Cognition in the wild*. Cambridge: MIT Press.
- Jasanoff, S., Markle, G., Peterson, J., & Pinch, T. (Eds.). (2001). *Handbook of science and technology studies*. Thousand Oaks: Sage.
- Jegede, O. J., & Aikenhead, G. S. (1999). Transcending cultural borders: Implications for science teaching. *Research in Science and Technological Education*, 17, 45–66.
- Kant, I. (1952). *The critique of judgement* (James Creed Meredith, Trans.). Oxford: Clarendon Press.
- Kawagley, A.O., Norris-Tull, D., & Norris-Tull, R.A. (1998). The indigenous worldview of Yupiaq culture: Its scientific nature and relevance to the practice and teaching of science. *Journal of Research in Science Teaching*, 35, 133–144.
- Kincheloe, J. L., McKinley, E., Lim, M., & Barton, A. C. (2006). Forum: A conversation on “sense of place” in science learning. *Cultural Studies of Science Education*, 1, 143–160.
- Knorr, K. D. (1979). Tinkering toward success: Prelude to a theory of scientific practice. *Theory and Society*, 8, 347–376.
- Knorr-Cetina, K. (1999). *Epistemic cultures: How the sciences make knowledge*. Cambridge: Harvard University Press.
- Kuhn, T. S. (1970). *The structure of scientific revolutions* (2nd ed.). Chicago: University of Chicago Press.
- Lacan, J. (1966). *Écrits* [Ecrits]. Paris: Seuil.
- Latour, B. (1987). *Science in action: How to follow scientists and engineers through society*. Milton Keynes: Open University Press.
- Latour, B. (1988). *The pasteurization of France*. Cambridge: Harvard University Press.
- Latour, B. (1992). *Aramis ou l'amour des techniques* [Aramis or the love of technology]. Paris: Éditions la Découverte.
- Latour, B. (1993). *La clef de Berlin et autres leçons d'un amateur de sciences* [The key to Berlin and other lessons of a science lover]. Paris: Éditions la Découverte.
- Latour, B. (1999). *Pandora's hope: Essays on the reality of science studies*. Cambridge: Harvard University Press.
- Lavoie, J. (1998, October 17). Moth imperils B.C. economy. *Times Colonist*, A1, A2.
- Leach, J., Millar, R., Ryder, J., & Séré, M. G. (2000). Epistemological understanding in science learning: The consistency of representations across contexts. *Learning and Instruction*, 10, 497–527.
- Lee, S. H. (2002). Science in the community: An ethnographic account of social material transformation (Doctoral Dissertation, University of Victoria, 2001). Dissertation Abstracts International—A 63/05, p. 1772. Retrieved March 27, 2009, from ProQuest Dissertation & Theses. (UMI No. NQ68133).
- Lee, Y.-J., & Roth, W.-M. (2006). Learning about workplace learning and expertise from Jack: A discourse analytic study. *Journal of Workplace Learning*, 14, 205–219.
- Lektorsky, V. A. (1984). *Subject, object, cognition*. Moscow: Progress.
- Leontjew, A. N. (1982). *Tätigkeit, Bewusstsein, Persönlichkeit* [Activity, consciousness, personality]. Köln: Studien zur Kritischen Psychologie.
- Leontyev, A. N. (1981). *Problems of the development of the mind*. Moscow: Progress.
- Lim, M., & Calabrese Barton, A. (2006). Science learning and a sense of place in a urban middle school. *Cultural Studies of Science Education*, 1, 107–142.
- Livingston, E. (1995). *An anthropology of reading*. Bloomington: Indiana University Press.

- Lucas, K. B., & Roth, W.-M. (1996). The nature of scientific knowledge and student learning: Two longitudinal case studies. *Research in Science Education*, 26, 103–129.
- Lynch, M. (1991). Method: Measurement—ordinary and scientific measurement as ethnomethodological phenomena. In G. Button (Ed.), *Ethnomethodology and the human sciences* (pp. 77–108). Cambridge: Cambridge University Press.
- Mader, S.S. (Ed.). (2003). *Inquiry into life* (10th edn). New York: McGraw-Hill.
- Maier, E., & Van Wijk, P. (1999). *Nectar bovenbouw biologie 2, deel 1*. Groningen: Wolters-Noordhoff.
- Marx, K., & Engels, F. (1969). *Werke Band 3* [Works: Vol. 3]. Berlin: Dietz.
- Matthews, M. (1994). *Science teaching: The role of history and philosophy of science*. New York: Routledge Press.
- Mayr, E. (1997). *This is biology, the science of the living world*. Cambridge: Belknap Press.
- McKinley, E. (1996). Towards an indigenous science curriculum. *Research in Science Education*, 26, 155–167.
- Mead, M., & Métraux, R. (1957). Image of the scientist among high school students: A pilot study. *Science*, 126, 384–390.
- Merleau-Ponty, M. (1964). *Le visible et l'invisible* [The visible and the invisible]. Paris: Gallimard.
- Miller, K.R., & Levine, J. (Eds.). (1998). *Biology*. Needham, MA: Prentice Hall.
- Moje, E. B., McIntosh Ciechanowski, K., Kramer, K., Ellis, L., Carrillo, R., & Collazo, T. (2004). Working toward third space in content area literacy: An examination of everyday funds of knowledge and discourse. *Reading Research Quarterly*, 39, 38–71.
- Nancy, J.-L. (1993). Éloge de la mêlée [Eulogy of the mêlée]. *Transeuropéennes*, 1, 8–18.
- Nancy, J.-L. (2000). *Being singular plural*. Stanford: Stanford University Press.
- National Commission on Excellence in Education (NCEE). (1983). *A nation at risk: The imperative for educational reform*. Washington, DC: U.S. Government Printing Office.
- National Research Council (NRC). (1996). *National science education standards*. Washington, DC: National Academy Press.
- Newton, I. (1934). *Philosophiae naturalis principia mathematica, Book 1* (A. Motte Trans., Florian Cajori Rev.). Berkeley: University of California Press. (Original work published 1689/1729)
- Norris, S. P., & Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education*, 87, 224–240.
- Osborne, J. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education*, 25, 1049–1079.
- Packard, B. W.-L., & Nguyen, D. (2003). Science career-related possible selves of adolescent girls: A longitudinal study. *Journal of Career Development*, 29, 251–263.
- Pasteur, L. (1881/2002) Summary report of the experiments conducted at pouilly-le-fort, near melun, on the anthrax vaccination (T. Dasgupta, Trans.). *Yale Journal of Biology and Medicine*, 75, 59–62. (Original work published in 1881).
- Pickering, A. (1995). *The mangle of practice*. Chicago: University of Chicago Press.
- Point, S. (1991). Understanding native activism. In D. Jensen & C. Brooks (Eds.), *In celebration of our survival: The first nations in British Columbia*. Vancouver: UBC Press.
- Pozzer, L. L., & Roth, W.-M. (2003). Prevalence, function, and structure of photographs in high school biology textbooks. *Journal of Research in Science Teaching*, 40, 1089–1114.
- Preziosi, D. (1986). The multimodality of communicative events. In J. Deely, B. Williams, & F. E. Kruse (Eds.), *Frontiers in semiotics* (pp. 44–50). Bloomington: Indiana University Press.
- Redfield, P. (1996). Beneath a modern sky: Space technology and its place on the ground. *Science, Technology & Human Values*, 21, 251–274.
- Rennie, L. J., Feher, E., Dierking, L. D., & Falk, J. H. (2003). Toward an agenda for advancing research on science learning in out-of-school settings. *Journal of Research in Science Teaching*, 40, 112–120.
- Ricœur, P. (1973). The model of the text: Meaningful action considered as a text. *New Literary History*, 5, 91–117.

- Rittelmeyer, C. (2002). *Pädagogische Anthropologie des Leibes: Biologische Voraussetzungen der Erziehung und Bildung* [Pedagogical anthropology of the lived body: Biological conditions of education and bildung]. Weinheim: Juventa-Verlag.
- Ritter, B., Coombs, R. F., & Drysdale R. B. (Eds.). (1996). *Nelson biology* (British Columbia ed.). Scarborough, ON: Nelson Canada (Thomson).
- Roberts, D. A. (2007). Scientific literacy/science literacy. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 729–780). Mahwah: Lawrence Erlbaum Associates.
- Rorty, R. (1979). *Philosophy and the mirror of nature*. Princeton: Princeton University Press.
- Roth, W.-M. (1995). *Authentic school science: Knowing and learning in open-inquiry science laboratories*. Dordrecht: Kluwer Academic Publishers.
- Roth, W.-M. (1996). The co-evolution of situated language and physics knowing. *Journal of Science Education and Technology*, 5, 171–191.
- Roth, W.-M. (2001). “Authentic science”: Enculturation into the conceptual blind spots of a discipline. *British Educational Research Journal*, 27, 5–27.
- Roth, W.-M. (2003a). Scientific literacy as an emergent feature of human practice. *Journal of Curriculum Studies*, 35, 9–24.
- Roth, W.-M. (2003b). *Toward an anthropology of graphing: Semiotic and activity theoretic perspectives*. Dordrecht: Kluwer Academic Publishers.
- Roth, W.-M. (2004). “Tappen Im Dunkeln”. Der Umgang mit Unsicherheiten und Unwägbarkeiten während des Forschungsprozesses [Groping in the dark: Dealing with uncertainties and unpredictabilities in scientific research]. *Zeitschrift für Qualitative Bildungs-, Beratungs-, und Sozialforschung*, 5, 155–178.
- Roth, W.-M. (2005). *Doing qualitative research: Praxis of method*. Rotterdam: Sense Publishers.
- Roth, W.-M. (2007). Toward a dialectical notion and praxis of scientific literacy. *Journal of Curriculum Studies*, 39, 377–398.
- Roth, W.-M. (2008a). Bricolage, métissage, hybridity, heterogeneity, diaspora: Concepts for thinking science education in the 21st century. *Cultural Studies of Science Education*, 3, 891–916.
- Roth, W.-M. (2008b). Constructing community health and safety. *Municipal Engineer*, 161, 83–92.
- Roth, W.-M. (2008c). Where are the cultural-historical critiques of “back to the basics”? *Mind, Culture, and Activity*, 16, 269–278.
- Roth, W.-M. (2009a). *Dialogism: A Bakhtinian perspective on science language and learning*. Rotterdam: Sense Publishers.
- Roth, W.-M. (2009b). Living with chronic illness: On (medical) science and scientific literacy in everyday life. In W.-M. Roth (Ed.), *Science education from people for people: Taking a stand (point)* (pp. 146–171). New York: Routledge.
- Roth, W.-M. (2009c). Radical uncertainty in scientific discovery work. *Science, Technology & Human Values*, 34, 313–336.
- Roth, W.-M. (Ed.). (2009d). *Science education from people for people: Taking a stand (point)*. New York: Routledge.
- Roth, W.-M. (2010a). An anthropology of reading science texts in online media. *Semiotica*, 182, 409–442.
- Roth, W.-M. (2010b). Vygotsky’s dynamic conception of the thinking-speaking relationship: A case study of science lectures. *Pedagogies: An International Journal*, 5, 49–60.
- Roth, W.-M. (2010c). Activism: A category for theorizing learning. *Canadian Journal of Science, Mathematics, and Technology Education*, 10, 278–291.
- Roth, W.-M., & Barton, A. C. (2004). *Rethinking scientific literacy*. New York: Routledge.
- Roth, W.-M., & Bowen, G. M. (1999a). Complexities of graphical representations during lectures: A phenomenological approach. *Learning and Instruction*, 9, 235–255.
- Roth, W.-M., & Bowen, G. M. (1999b). Digitizing lizards or the topology of vision in ecological fieldwork. *Social Studies of Science*, 29, 719–764.
- Roth, W.-M., & Bowen, G. M. (2003). When are graphs ten thousand words worth? An expert/expert study. *Cognition and Instruction*, 21, 429–473.

- Roth, W.-M., & Hsu, P.-L. (2008). Interest and motivation: A cultural historical and discursive psychological approach. In J. E. Larson (Ed.), *Educational psychology: Cognition and learning, individual differences and motivation* (pp. 81–105). Hauppauge: Nova Science.
- Roth, W.-M., & Lee, S. (2002). Scientific literacy as collective praxis. *Public Understanding of Science, 11*, 33–56.
- Roth, W.-M., & Lee, Y.-J. (2007). “Vygotsky’s neglected legacy”: Cultural-historical activity theory. *Review of Educational Research, 77*, 186–232.
- Roth, W.-M., & McGinn, M. K. (1998). >unDELETE science education: /lives/work/voices. *Journal of Research in Science Teaching, 35*, 399–421.
- Roth, W.-M., Bowen, G. M., & McGinn, M. K. (1999). Differences in graph-related practices between high school biology textbooks and scientific ecology journals. *Journal of Research in Science Teaching, 36*, 977–1019.
- Roth, W.-M., Lee, Y. J., & Boyer, L. (2008a). *The eternal return: Reproduction and change in complex activity systems—The case of salmon enhancement*. Berlin: Lehmanns Media.
- Roth, W.-M., Riecken, J., Pozzer, L. L., McMillan, R., Storr, B., Tait, D., Bradshaw, G., & Pauluth Penner, T. (2004). Those who get hurt aren’t always being heard: Scientist-resident interactions over community water. *Science, Technology, & Human Values, 29*, 153–183.
- Roth, W.-M., van Eijck, M., Reis, G., & Hsu, P.-L. (2008b). *Authentic science revisited: In praise of diversity, heterogeneity, hybridity*. Rotterdam: Sense Publishers.
- Rutherford, F. J., & Ahlgren, A. (1989). *Science for all Americans*. New York: Oxford University Press.
- Ryder, J. (2001). Identifying science understanding for functional scientific literacy. *Studies in Science Education, 36*, 1–44.
- Ryder, J., Leach, J., & Driver, R. (1999). Undergraduate science students’ images of science. *Journal of Research in Science Teaching, 36*, 201–219.
- Saanich Indian School Board (SISB), Elliott, J. Sr., Guilar, J., & Swallow, T. (2008, February 28–March 1). *SNITCEL: Learning from a traditional place*. Paper presented at the Aboriginal Learning Knowledge Centre 2nd Annual National Conference: Seeing Ourselves in the Mirror, Vancouver, British Columbia, Canada.
- Sadler, P. M., & Tai, R. H. (2001). Success in introductory college physics: The role of high school preparation. *Science Education, 85*, 111–136.
- Sanger, F., Air, G. M., Barrell, B. G., Brown, N. L., Coulson, A. R., Fiddes, C. A., Hutchison, C. A., Slocombe, P. M., & Smith, M. (1977). Nucleotide sequence of bacteriophage phi X174 DNA. *Nature, 265*, 687–695.
- Séré, M. G., Fernández-González, M., Gallegos, J. A., González-García, F., De Manuel, E., Perales, F. J., & Leach, J. (2001). Images of science linked to labwork: A survey of secondary school and university students. *Research in Science Education, 31*, 499–523.
- Sewell, W. H. (1999). The concept(s) of culture. In V. E. Bonnell & L. Hunt (Eds.), *Beyond the cultural turn: New directions in the study of society and culture* (pp. 35–61). Berkeley: University of California Press.
- Shamos, M. H. (1995). *The myth of scientific literacy*. New Brunswick: Rutgers University Press.
- Sharrock, W., & Button, G. (1991). The social actor: Social action in real time. In G. Button (Ed.), *Ethnomethodology and the human sciences* (pp. 137–175). Cambridge: Cambridge University Press.
- Shaw, G. B. (1949). *Back to Methuselah*. London: Constable and Company.
- Sherman, W. (2004). Science studies, situatedness, and instructional design in science education: A summary and critique of the promise. *Canadian Journal of Science, Mathematics, and Technology Education, 5*, 443–465.
- Siegel, H. (2002) Multiculturalism, Universalism, and Science Education: In Search of Common Ground. *Science Education, 86*, 803–820.
- Sjøberg, S., & Schreiner, C. (2010). *The ROSE project: An overview and key findings*. Oslo: University of Oslo.
- Snively, G., & Corsiglia, J. (2001). Rediscovering indigenous science: Implications for science education. *Science Education, 85*, 6–34.

- Sobel, D. (2004). *Place-based education: Connecting classrooms and communities*. Great Barrington: Orion Society.
- Stanley, W. B., & Brickhouse, N. W. (2001). Teaching sciences: The multicultural question revisited. *Science Education*, 85, 35–49.
- Star, S. L. (1995). The politics of formal representations: Wizards, gurus, and organizational complexity. In S. L. Star (Ed.), *Ecologies of knowledge: Work and politics in science and technology* (pp. 88–118). Albany: State University of New York Press.
- Suzuki, D. (1989). *Inventing the future: Reflections on science, technology, and nature*. Toronto: Stoddart.
- Tobin, K., & Roth, W.-M. (2006). *The culture of science education: Its history in person*. Rotterdam: Sense Publishers.
- Turner, N. J. (2005). *The Earth's Blanket: Traditional Teachings for Sustainable Living*. Vancouver, BC: Douglas and McIntyre.
- Umeek/Atleo, E. R. (2004). *Tsawalk: A Nuu-chah-nulth worldview*. Vancouver: University of British Columbia Press.
- United Nations High Commissioner for Human Rights (UNHC-HR). (1994). *Draft United Nations declaration on the rights of indigenous peoples*. [http://www.unhcr.ch/huridocda/huridoca.nsf/\(Symbol\)/E.CN.4.SUB.2.RES.1994.45.En](http://www.unhcr.ch/huridocda/huridoca.nsf/(Symbol)/E.CN.4.SUB.2.RES.1994.45.En). Accessed 15 Feb 2011.
- van Eijck, M. (2006). *Teaching quantitative concepts with ICT in pre-university biology education: The case of datalogging the heart*. Amsterdam: Eigen Beheer.
- van Eijck, M. W. (2007). Towards authentic forms of knowledge. *Cultural Studies of Science Education*, 2, 606–613.
- van Eijck, M. W., & Roth, W.-M. (2007). Improving science education for sustainable development. *PLoS Biology*, 5, 2763–2769.
- van Eijck, M. W., & Roth, W.-M. (2008). Representations of scientists in Canadian high school and college textbooks. *Journal of Research in Science Teaching*, 45, 1059–1082.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: Harvard University Press.
- Vygotsky, L. S. (1986). *Thought and language*. Cambridge: MIT Press.
- Vygotsky, L. S. (1989). Concrete human psychology. *Soviet Psychology*, 27(2), 53–77.
- Wang, C., Bowen, D. J., & Kardia, S. L. (2005). Research and practice opportunities at the intersection of health education, health behavior, and genomics. *Health Education Behaviour*, 32, 686–701.
- Watson, J. D. (1968). *The double helix: A personal account of the discovery of the structure of DNA*. New York: Atheneum.
- Willett, D. (2009, February 11). *Press release: Graduates hit by twin challenges of recession and skills shortages*. <http://www.davidwilletts.co.uk/2009/02/11/graduates-hit-by-twin-challenges-of-recession-and-skills-shortages/>. Accessed 15 Feb 2011.
- Wittgenstein, L. (1953/1996). *Philosophische Untersuchungen* [Philosophical investigations] (2nd ed.). New York: Macmillan.
- Wittgenstein, L. (2000). *Wittgenstein source: Bergen text edition*. <http://www.wittgensteinsource.org>. Accessed 22 Sept 2010.
- Wood, C. C. (1995). Life history variation and population structure in sockeye salmon. In Nielsen, J. L. (Ed.) *Evolution and the Aquatic Ecosystem* (pp. 195–216). Bethesda, MD: American Fisheries Society Symposium 17.
- Wood, P. (2008). How our culture keeps students out of science. *The Chronicle of Higher Education*, 54(48), A56.

Index

A

- Aboriginal, 55, 58, 139, 155, 177, 178, 184, 185, 191, 196, 198
 - peoples, xviii, 186
 - students, xviii, 181
- Activity, 8, 10, 29, 31, 36, 41, 47, 51, 64, 84, 86–90, 106, 113, 114, 116–119, 130, 136, 137, 143, 146, 154, 158, 167, 174, 175, 177, 178, 180, 181, 183, 184, 189, 191, 201, 203, 204, 211, 214–216, 220–224
 - collective, 10, 85, 86, 88, 89
 - educational, xxvi, 88
 - human, 8, 9, 14, 17, 19, 20, 23, 25, 61, 62, 64, 65, 74, 84–86, 90, 106, 109, 111, 112, 115, 116, 121, 123, 134, 136, 166, 175, 185
- Artifact, xv, xiv, xvii, 5, 9–12, 14, 19, 20, 22, 47, 61–67, 70, 76, 77, 108, 115, 119, 130, 153, 159, 210, 216, 219

B

- Bakhtin, M.M., xx, xxv, xix, xxii, xxvi, xviii, xxiii, xxviii, 29, 56, 116, 129, 133, 134, 144, 148–150, 160, 164, 211, 216, 217, 225, 226
 - circle, xxv, xix, xxiii, 148–150
- Boundary object, 122, 124, 125, 127, 128

C

- Cartesian
 - graphs, 11, 35
 - plane, xxiv
 - plots, 28

- CHAT. *See* Cultural-historical activity theory (CHAT)
- Chronotope, xxiv, xxiii, 134, 148, 150–154, 156, 157, 159–162
- Conceptions, xvii, 58, 59, 73, 82, 83, 94, 100, 101, 108, 109, 148
- Constructivism, xv, xvi, xvii, 76, 81, 82, 84, 99, 103, 106, 112, 205, 226
- Conventional, 41
- Cultural border crossing, xviii, 70
- Cultural centralization, xx, xxv, xxvii, 225
- Cultural diversity, xxv, xxvi, xxvii, 155, 186, 225, 226
- Cultural-historical activity theory (CHAT), 8, 13, 18, 61, 106, 129, 173, 183, 185, 206, 217
- Culture, xviii, 57–60, 70, 77, 125, 127, 133, 142, 147, 157, 160, 179, 182, 184–188, 191, 193, 195, 198, 207, 217, 220, 225–227
 - epistemic, 69, 78, 113
 - EuroAmerican, 155
 - First Nations, 138, 188, 189
 - fluidity of, 155
 - human, 186
 - Maori, 147
 - proto, 220
 - Western, 53, 152
 - WSÁNEĆ, 144
 - Yupiaq, 60
- Curriculum, xv, xxi, xiv, xxvii, 4, 7, 59, 70, 80–82, 87, 94, 99, 104, 105, 108, 109, 113, 141, 155, 165, 167, 168, 171–174, 181, 182, 196, 215, 220, 226
 - development, 206
 - genomics, 89

- Curriculum (*cont.*)
 materials, xiv, 4
 reform, 86–89
 science, xxi, xxv, xxvi, xxvii, xviii, 3, 4, 7,
 22, 55, 58, 74, 78, 83, 86, 88, 102, 111,
 112, 114, 173, 174, 181, 199, 206, 225,
 226
 STS, 102
- D**
 Darwin, xxii, 10, 11, 15–20, 22, 23
 Decoding, xxv, xvi, xvii, 226
 Derrida, J., xviii, 29, 30, 38, 56, 84, 101, 227
 Descartes, xxiv, 59
 Dialog, xxv, xxvii, 37, 56, 69, 71, 99, 111, 130,
 144, 150, 153, 156, 158, 159, 161, 162
 openended, 149, 162
 Dialogical, xix, xxiv, xiii, 37, 47, 50, 56, 99,
 150, 152, 161, 162, 226
 relation, 47, 50, 161, 162
 transaction, 161, 162
 Discourse, xvi, xxv, xix, xxiv, xxvi, xxvii,
 xviii, 25, 44, 53, 54, 56, 69, 77, 78, 84,
 92–95, 104, 105, 109, 133, 148, 149,
 154, 161, 162, 167, 173, 180, 202, 214,
 222
 biophysical, xxiv
 dominant, xxvi
 established, xxvii
 hybridized, 102
 ideological, xxiv, 134
 natural, 98
 novelizing, xxvi, xxviii, 92, 108, 164, 178,
 179, 223
 public, 94
 of science, xxv, xxvi, xxvii, xviii, 25, 54,
 56, 92–95, 109, 133, 162
 of science education, xxvi, xxvii, 25, 54,
 56, 92–95, 109, 133, 162
 of science education research, 25
 scientific, xxv, xvi, xxiv, xxvi, xvii, xxvii,
 53, 83, 84, 105, 173, 181, 198, 209, 223
 unifying, xxvi
 Division of labor, 9, 10, 14, 15, 21–23, 62, 64,
 86, 87, 107, 112, 115, 123, 127–130,
 168, 171, 173, 174, 185, 220, 221, 224
 Draw-A-Scientist Test, 4
- E**
 Ecology, xxv, xxii, 30, 36, 39, 49, 69, 86, 136,
 140, 167, 208
- Einstein, A., 2, 53, 147, 148
 paradigm, 148, 150
 Encoding, xvi, 226
 Epic, xv, xx, xxv, xix, xiv, xxii, xviii, xxviii,
 2, 7, 8, 14, 23, 30, 43, 48, 49, 51, 53,
 55, 73, 76, 79, 86, 87, 93, 109, 111,
 129–131, 133, 134, 173, 186, 199, 202,
 204, 206, 222
 of science, xiv, 29
 Epicization, xv, xx, xiv, xxi, xxv, xxvi, xxii,
 xiii, xxiii, xxviii, 2, 3, 5, 7, 22–25, 54,
 55, 78, 86, 90, 92, 111, 112, 129, 130,
 134, 164, 225, 226
 Ethnography, 25, 31, 42, 45, 51, 76, 116, 119,
 134, 139, 151, 187, 188, 210
- F**
 Fabricius, H., xv
 First Nations, 62, 144, 151, 154, 157, 158, 160,
 161, 177, 180, 186, 199
 community, 137, 154, 156, 157, 159, 183,
 187–190
 Fullness of life, 201–224
- G**
 Galen, xv
 Galileo, G., xxiv, 2
 Genre
 in-the-making, xxv, xxvii
 literary, xxv, xix, xxvi, xxvii, 56
 speech, 84, 105
 Graphing, xxiv, xxii, 27–29, 32, 36, 50, 103,
 226
 Graphs, xxv, xxii, xxiii, 3, 6, 27–37, 39–42, 44,
 45, 47–51, 62, 96
 Grounding, 33, 109, 216
- H**
 Heroes, 2, 13, 18, 23, 24, 27, 33, 44, 48, 49, 51
 of science, 27, 44
 Heroic, 2, 6, 7, 23, 30, 33, 35, 41, 48, 76, 202
 Heterogeneity, 60, 61, 65, 69, 70, 149, 160,
 182, 187
 Heterogeneous, 7, 60, 61, 70, 78, 106, 182,
 186, 209
 Heteroglossia, xx, xix, 149
 Homogeneous, 59, 60, 65, 66, 70
 Hybridity, 60, 187

I

- Identity, 8, 10, 13, 23, 59–61, 70, 145, 147,
149, 151, 162, 185, 186, 188, 190, 191,
194–196, 198, 200
cultural, 59, 161, 181, 185–189, 191, 192,
194–200
of scientists, 13
scientists' narrative, 23
static, 147
- Image(s) of science, xv, xxi, xiv, xvii,
xxviii, 7, 24, 27, 53, 111–116, 118,
119, 122, 123, 128–131, 164, 173,
174, 199
epic, xiv, xviii
epicized, xxviii, 2, 36, 53, 164, 200, 223
epic nature of, xiv
novelized, xxviii, 54, 55, 92, 164, 198–200
stereotypic, 4
students, xiv, xxviii, 3, 92, 111–114, 116,
119–123, 128–131
- Images of scientists, xiii
- Imagination, xv, xiv, xxv, xiii, xxviii, 24, 25,
55, 92, 111, 112, 164, 179, 201, 204,
225
dialogic, 227
of science, xiv, xiii, xxviii, 25, 55, 111, 166,
179, 201, 204, 225

L

- Laboratory, xiv, 4, 6, 7, 9, 11, 12, 19, 20, 46,
50, 60, 65, 66, 69, 87–90, 112, 116–119,
121, 122, 124, 130, 131, 158–160, 170,
178, 183, 184, 192, 193, 197–200, 209,
210, 215
- Language
aboriginal, 155
everyday, xxv, xix, 150
Salish, 188
scientific, xxv, 50, 178, 199, 200
unitary, xx, xxv, xix, xxii, xxvi, xviii, xxvii,
xxiii, 7, 22, 93, 225, 227
- Linguistic norms, xxv, xix, xviii
- Linguistic tools, xvii

M

- Mead, M., xiv
Mélee, 60, 179, 187, 188, 191, 194–198, 227
Mendel, G., 10, 11, 15, 18–23, xxii
Métraux, R., xiv, xiii

N

- Narrative, xix, xxv, xxiv, xiii, 2, 8, 13, 14,
23–25, 27, 47, 51, 53, 61–64, 70, 82,
123, 129, 133, 134, 143, 145, 148–151,
153, 158, 159, 161, 162, 181, 222
- Nature of Science (NoS), xiv
- Needham, J., 5, 6, 13, 14, 21
- Newton, I., 2, 147
- NoS. *See* Nature of Science (NoS)
- Novelization, xv, xiv, xxv, xiii, xxvii, xxviii,
25, 37, 53, 73–75, 86, 87, 89, 90, 93,
94, 101, 108, 109, 111, 112, 129, 131,
165, 166, 173, 177, 179, 186–188, 191,
192, 197, 198, 201, 204, 205, 209, 215,
216, 219, 225–227
of science, xxv, xxvii, 27, 29, 226
in science education, 73, 177, 205
of science education discourse, 108
of scientific discourse, xxvii

P

- Pasteur, L., 5, 6, 9–13, 18, 19, 21, 22, 65, 67
- Place
chronotopic notion of, 153

S

- Science
language of, xvii, 93, 225
ready-made, xvii, 19, 23, 76
social studies of, xiv, xvii, 6, 7, 19, 24, 69,
70, 174
Western, xviii, 58, 60, 71, 155
Western Modern, 55, 56, 155
- Science education, xx, xix, xiv, xxv, xxvi, xxii,
xvii, xiii, xviii, xxvii, xxviii, 3, 4, 24,
53–58, 60, 73–75, 80, 82, 86–88, 90,
92–94, 99–101, 103, 106, 109, 111,
112, 116, 130, 131, 133, 139, 141,
142, 153–155, 160–162, 164, 165, 174,
178–182, 186, 198, 200–202, 205–207,
211, 215, 218, 219, 221, 225, 226
aims of, xxvii, 55, 80, 82, 92, 93, 99, 101
discourse of (*see* Discourse)
language of, xxvi, xxvii
linguistic characteristics of, xxvi
novelizing, 73, 86, 133, 134, 162, 164, 167,
202, 205, 206, 223, 224
practice of, xiv, 23
representation practices in, xvi, xiv

Science-technology-society (STS), xiv, 101
 Scientific literacy
 cultural, 104
 functional, 103, 104
 in the wild, 93–95, 98–100, 102–109, 208
 Scientific method, 4, 7, 21, 76, 103, 193, 195
 Scientists
 stereotypic images of, 3, 4, 7
 students' images of, 3, 4
 Semiotic analysis, xviii, 8, 12, 13, 37
 Semiotics, 29, 32, 33
 Signified, 8, 28, 29, 32–34, 37, 39, 41, 45, 48, 49
 Signifier, 28–30, 32–35, 37–41, 45, 47–51, 147
 SNITCEL, 138–141, 143, 144, 146, 148, 149, 151–159, 161, 162, 178, 179, 189, 190, 193
 Spallanzani, L., 5, 6, 13, 14, 21
 Structuring, 8, 23, 33–35, 212
 STS. *See* Science-technology-society (STS)

T

Technician, 28, 31, 42–44, 51, 117–119, 121, 124, 126–129, 167, 183, 192, 193, 198, 200, 213, 215, 222
 Text, xx, xxv, xxi, xix, xxiv, xviii, 5, 8, 10–14, 22, 24, 25, 29, 30, 32, 41, 42, 48, 60–62, 64, 76, 84, 106, 107, 129, 148
 caption, xv, 12, 13

 main, xx, xxiii, 5, 6, 12, 13
 multimodal, 8, 23, 32, 35
 Textbook(s), xxv, xxi, xxiv, xxii, xxiii, 4, 5, 12, 13, 20, 24, 27, 30
 biology, xxv, 23
 ecology, 30
 science, xv, xxi, xxii, xxiii, xxviii, 2–8, 11, 12, 14, 18, 22–25, 27, 76, 201

V

Voice, xix, xxv, xiii, 53, 56, 60, 69, 84, 98, 101, 105, 106, 139, 143–149, 154, 155, 158, 161, 162, 167, 173, 177, 190, 199, 202
 academic, 190
 critical, 187
 First Nations, 190
 indigenous, 153, 156
 multiple, 51
 multitude of, 144–146, 149
 scientific, 162, 165
 Western, 157

W

Watson, J., 11, 22, 23, 25, 41
 WMS. *See* Science
WSÁNEĆ, 62–64, 67, 71, 138, 139, 144, 145, 148, 149, 151, 152, 156–158
 First Nation, 138, 156