

Big Data's Call to Philosophers of Education

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Article abstract

This paper investigates the intersection of big data and philosophy of education by considering big data's potential for addressing learning via a holistic process of coming-to-know. Learning, in this sense, cannot be reduced to the difference between a pre- and post-test, for example, as it is constituted at least as much by qualities of experience as it is the situation, process of inquiry and its consequences. Long a perennial concern of philosophers of education, the author suggests that big data offers a budding opportunity for philosophers to engage in dialogue with empirical research in order to better understand the process of learning as coming-to-know. Drawing on John Dewey's theory of inquiry and his philosophy of experience, the author demonstrates ways that both empirical and philosophical research stands to benefit from cross-dialogue. In offering an unprecedented glimpse of empirical detail, the author proposes that big data stands to afford new insights into this most complex human process and that Dewey's philosophy offers a vital lens of interpretation that can help philosophers of education to make use of this data in addressing the perennial question of how humans come-to-know.

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Abstract: This paper investigates the intersection of big data and philosophy of education by considering big data's potential for addressing learning via a holistic process of coming-to-know. Learning, in this sense, cannot be reduced to the difference between a pre- and post-test, for example, as it is constituted at least as much by qualities of experience as it is the situation, process of inquiry and its consequences. Long a perennial concern of philosophers of education, the author suggests that big data offers a budding opportunity for philosophers to engage in dialogue with empirical research in order to better understand the process of learning as coming-to-know. Drawing on John Dewey's theory of inquiry and his philosophy of experience, the author demonstrates ways that both empirical and philosophical research stand to benefit from cross-dialogue. In offering an unprecedented glimpse of empirical detail, the author proposes that big data stands to afford new insights into this most complex human process, and that Dewey's philosophy offers a vital lens of interpretation that can help philosophers of education to make use of this data in addressing the perennial question of how humans come-to-know.

We are in the midst of a “big data” revolution. Enthusiasts promise that this revolution will transform how we live, work, and think (Mayer-Schonberger & Cukier, 2013), while critics warn that big data and big brother are one and the same (see K.N.C., 2014 for an example of how this type of criticism has played out in education). In the realm of education, it is said that big data will dramatically transform the way we approach teaching, learning, assessment, and research (Bienkowski, Feng, & Means, 2012; DiCerbo & Behrens, 2014; Pea, 2014; West, 2012). Although we do not yet know the full extent of this transformation, one thing we can almost certainly know is that big data will mean big implications for education. Yet, in the midst of this transformation, we would do well to remember that a chief concern of education—learning via a process of coming-to-know—is no more complex a human practice than it ever was. Thus, we hear big data's call.

In this paper, I will consider big data's potential for addressing learning via a holistic process of coming-to-know. A perennial concern of philosophers of education, I suggest that big data offers a budding opportunity for philosophers to engage in dialogue with empirical researchers in order to better understand the process of learning as coming-to-know. Learning, in this sense, cannot be reduced to the difference between a pre- and post-test, for example, as it is constituted at least as much by qualities of experience as it is the situation, process of inquiry and its consequences. In offering an unprecedented glimpse of empirical detail, I maintain that big data stands to afford new insights into

this most complex human process. The question before us is how philosophers of education might make use of this data in order to address the perennial question of how humans come-to-know.

Approaching How Humans Come-to-Know

As far back as Plato's *Meno*, we encounter a theory of coming-to-know as recollection through Socrates' conclusion that, in recognizing a geometric truth, the slave boy was recovering forgotten knowledge that had long resided within his soul. John Locke (1689/1996) later proposed the exact opposite, that we are born with a *tabula rasa*, a blank slate, and that all knowledge is a matter of experience. John Dewey (1938/2007) also thought that knowledge is a matter of experience, but critiqued both of these views because they underestimate the active role of the knower in the process of coming-to-know, which for Dewey is synonymous with inquiry (Dicker, 1973). Today we have learning theories spanning a huge range from behaviorism to social-situated learning that all seek to offer a better understanding of one of the most complex human processes. Like all perennial questions, that of how humans come-to-know continues to open up further and further layers of intricacy. And with so much of what learners do being ephemeral, there are many layers that we have yet to unlock.

Today, the question of how humans come-to-know is as important a concern for philosophers of education as it has ever been. Indeed, it is arguably the case that the stakes for answering this question have never been higher. Yet, as conveyed by Marcelo Suárez-Orozco, "[i]ndisputably [and regrettably], with regard to education, philosophers have lost their place of privilege" (2016, p. 63). There are many potential reasons for this, not the least of which is that, since the No Child Left Behind Act, the U.S. Department of Education has determined that only a certain kind of empirical research could be considered scientific and therefore worthy of funding (Towne & Shavelson, 2002). This pushed many types of educational research to the periphery. Today, much of the research in this area is driven by strict criteria that rely on randomized control trials that afford "gold standard" results, but research questions so narrow that they often eclipse the ground on which philosophical contributions are most fertile.

But in light of dramatic changes that are rapidly unfolding with advancements in technology, the ground of educational research is shifting along with the radical transformations that are occurring within society. In the US, this comes through in a report to the White House stating "we are in the midst of a social, economic, and technical revolution" (Podesta, Pritzker, Moniz, Holdren, & Zients, 2014, p. iii), a revolution that is dramatically transforming the ways we communicate, socialize, spend leisure time, and conduct business, not to mention the ways we learn (Cope & Kalantzis, 2009). Our emails, texts, tweets, Facebook posts, web navigation paths, and web purchases are examples of this type of change—and all of these interactions leave behind a trail of data that is incidentally recorded, all time stamped, and often geo-located. This immense trail of data is having and will continue to have a dramatic impact on research in the social sciences. Termed "big data," this river of information is significant not only for its size, but perhaps even more so because of the differences between this data and traditional sources of evidence that not only make room for, but urgently call for a theoretical lens.

The irony of big data is that it is not just quantitative. As stated by Bill Cope and Mary Kalantzis, "[i]t demands more conceptual, theoretical, interpretative, hermeneutical—indeed qualitative—intellectual work than ever" (2015a, p. 226). Adding to this list, I maintain that philosophical inquiry is

not only relevant, but critically needed. Grounded in the history of human thought with reference to perennial concerns, philosophers shed light on connections and meanings that often lie well beneath the surface. This can provide theoretical groundings for emergent pedagogical approaches, research undertakings, and new social challenges we face in a digital age. Along these lines, philosophers stand to complement efforts in the burgeoning literature in “connected learning” and “connectivism” (see, for example, Ito et al., 2013; Siemens, 2005; Downes, 2010) and may help to address concerns that have been raised pertaining to a lack in theoretical rigor (Verhagen, 2006; Kop & Hill, 2008; Bell, 2011).

Contrary to claims that big data is now so big, so complete and so exhaustive that it can be allowed to speak for itself (see, for example, Anderson, 2008), the reality is that the opposite is true. A philosophical perspective is now needed more than ever in order to explain the meaning behind the numbers. Thus, in the current landscape of educational research, big data is allowing us to see layers of this most intricate human process that have never before been visible. Yet, in order to make use of this with regard to the perennial question of how humans-come-to-know, we need philosophers of education to take a seat at the table.

In accordance with Katariina Holma and Heidi Hyytinen’s recent conclusion that “educationally oriented research would benefit from a dialogue between philosophical and empirical research” (2015, p. 11), I propose that this is especially true with regard to research that utilizes big data.¹ By drawing on John Dewey’s theory of inquiry and his philosophy of experience, I will engage big data and the question of how humans come-to-know, demonstrating ways that both empirical and philosophical research stand to benefit from such a dialogue. I will begin by addressing big data, explaining what it is and what makes it different from other types of data. Next, I will consider how Dewey’s theory of inquiry might provide a helpful philosophical lens for interpreting big data. Continuing on, I will explore how big data might fruitfully inform and potentially advance philosophical inquiry by affording a view of micro-moments related to the experience of coming-to-know. In closing, I will look to potential dangers associated with big data, as philosophical critique will prove equally important moving forward as the landscape of educational research continues to shift in its wake.

What Is Big Data and What Makes It Different?

It is not enough to say that the revolution currently underway in educational research is due to the use of computers for learning purposes. Indeed, we have been using computers in education for five decades now. This began in the US in 1959 with the development of PLATO (Programmed Logic for Automatic Teaching Operations), a system for computer-assisted instruction developed at the University of Illinois. While technology-mediated learning in itself is not particularly new, more recent

¹ In addition to Holma and Hyytinen, there is a growing wealth of methodological literature that engages philosophical and empirical inquiry. A prime example of this can be found in experimental philosophy, which makes use of empirical data directly in philosophical inquiry (Knobe & Nichols, 2008). Further methodological considerations of philosophical inquiry and empirical approaches can be found in emergent literature on situated philosophy (Burbules & Knight Abowitz, 2008), non-ideal theory in philosophy of education (Moses, 2015), and neo-pragmatist philosophy of education (Bagheri Noaparast, 2015).

developments within the past half-decade allow for technology-mediated learning to take on unprecedented significance. With the development of cloud computing, we find a crucial shift from what might be thought of as personal computing to interpersonal computing. Essentially, this allows us to link together information that was previously isolated. “In the era of personal computing, data was effectively lost to anything other than individual access in a messy, ad hoc cacophony of files, folders, and downloaded emails. In the era of interpersonal computing, the social relations of information and communication can be systematically and constantly ordered” (Cope & Kalantzis, 2015b, p. 197). By linking data together, we amass a mountain of information that can be linked even further when connected with different systems for analysis. Here, we encounter the realm of “big data.”

As more and more learning occurs within the cloud, we are assembling an extraordinary amount of information about processes of social knowing occurring within learning-management systems, discussions in web forums and social media activity streams, web writing spaces and work portfolios, games and simulations. Incidentally recorded data from these sources can be linked with other sources such as student information systems that contain a wide variety of data points including things like demographics and grades. On the one hand, this amounts to a mass of untidy, inconsistent and hard-to-read data points. But at the same time, we are accumulating a mountain of potential evidence of learning that may be of great value to teachers, learners, and researchers. The trick is figuring out how to put all of this data to good use.

Beyond its bigness, what makes big data so interesting is what distinguishes it from data generally. Ironically, the main difference is not its bigness, but rather its smallness. That is, what makes big data fundamentally different is that the data points have become smaller. We can now capture everything from an answer to a question or a move in a simulation to a keystroke, a timestamp, or a click in a navigation path. “Learning has not become bigger. It’s just that the things we can record incidental to the learning process have become smaller, and these add up to a lot more data than we have ever had before—more data than a human can deal with, without computer-synthesized analytics” (Cope & Kalantzis, 2015b, p. 208).

This means that we can now detail and study evidence of learning that is embedded within the process of learning itself. A far cry from traditional methods that involve gathering evidence through means that are external to the process of learning (e.g., pre- or post-test, survey, interview, or focus group), big data opens up new ways to think about evidence of learning (for a fuller explanation, see Cope & Kalantzis, 2015b). The big data approach is to record everything that happens, producing a data record that can be analyzed retroactively. This is significant for many reasons. DiCerbo and Behrens hit on what is perhaps most important for philosophers of education:

We believe the ability to capture data from everyday formal and informal learning activity should *fundamentally change how we think about education*. Technology now allows us to capture fine-grained data about what individuals do as they interact with their environments, producing an “ocean” of data that, if used correctly, can give us a new view of how learners progress in acquiring knowledge, skills, and attributes. (2014, preface, emphasis added)

This process-oriented data is the key for creating room for philosophers of education at the table of educational research. Rather than traditional methods that “take one observation at one time from multiple people,” big data allows for “multiple observations of a single individual” that can afford “a more dynamic picture of how children learn” (McDermott, 2017, para. 15). This idea comes across in a

recent article in *The Economist*, which points out that these newly fashionable ideas of personalized learning for educational research have a long history, making reference to the learning approaches advocated by Jean-Jacques Rousseau and John Dewey. “America is in the very early stages of a big pedagogical experiment based on old ideas given new life by digital technology and the techies’ money” (McDermott, 2017, para. 30). The revolution is already underway.

Although it can be said that evidence of learning has always necessarily been embedded within the process of learning itself, what is new here is the grain size of recordable and analyzable data. So, while “it was never practicable to record every pen stroke made by every learner, every keystroke of every learner is incidentally recorded in log files and thus are potentially open to analysis” (Cope & Kalantzis, 2015a, p. 221). But this goes far beyond mere keystrokes. By studying knowledge artifacts that learners create in digital media such as a report on a science experiment, an artwork with exegesis, or a video story, traces of the knowledge production process become as important as the products themselves. Analysis can be opened to things like time-on-task, the sources used, peer feedback during the making, edit histories, and navigation paths through sources. In this we find quite literal traces of the rhythms of interaction with the environment that philosophers have long told us are central to learning.

So, instead of only seeing a student’s end-product such as an idea expressed in writing as we would in a traditionally submitted assignment, for example, big data can afford a trail of evidence related to the development of that idea over time. In this, we have the capacity (at least in theory) to trace the process that led to the idea. This may include interactions with other students and texts that will allow us to identify the germ that sparked it. And it will most certainly include a detailed record of the precise timing in which everything occurred. It will reveal whether the new idea came all at once or there was a slow process of working and reworking the idea before it came to fruition.

How might this level of precision allow us to better understand this process of coming-to-know? What insights will be afforded with the ability to drill down into every constituent data point in order to explore precisely what happened to produce a particular outcome? In what ways will this fine-grained level of precision allow us to peel back more layers of the process of coming-to-know? Answering these questions will become increasingly important for educational researchers. With this, a philosophical perspective will be crucial in order to explore the depths of what this mode of inquiry might yield.

Where Big Data Meets Philosophy of Education

Despite presumably common-sense claims that data can speak for itself, it cannot. Data is just data—it needs interpretation in order to be rendered meaningful. And if we are to take seriously the holistic activity of learning via a process of coming-to-know, a philosophical lens becomes indispensable. For this reason, I argue that research engaging big data calls for the rich theoretical lens that philosophy provides in order to make meaning from this data. But at the same time, I propose that philosophical research, too, stands to benefit richly from big data because it offers an unprecedented glimpse of verifiable detail that is related to the experience of coming-to-know. How might this inform and potentially advance our philosophical understanding of this experience?

The benefit of big data is that it affords an unprecedented level of precision for analyzing verifiable traces of the experiential process of inquiry. And the limit of big data is that no matter the level of precision with regard to this trail of evidence, it still does not tell us what it is to have such an

experience. Thus we encounter a nexus in which big data meets philosophy of education—a nexus that, I claim, has the potential to advance educational research in both domains.

How Dewey's Theory of Inquiry Can Help in Interpreting Big Data

Dewey's theory of inquiry describes a temporal process that, taken as a whole, comprises what he refers to as the "act of knowing." Rather than approaching knowledge as a cognitive state in which discrete items are fixed and can either be known or not known, Dewey understood knowledge to be the outcome of a process through which we gain "the ability to anticipate the consequences of putting things to be known through various changes" (Dicker, 1973, p. 208). Thus, for Dewey, we know something when we have the ability to anticipate how it functions; for example, when we can determine whether it fits meaningfully in a specific context or not. Accordingly, Dewey's approach to knowledge contrasts sharply with most traditional epistemological accounts that assign the knower a passive role in which the relation between knower and the thing known is analogous to that of a spectator and something visually apprehended (Dewey, 1929).

Such traditional epistemological accounts are pervasive within education and come to the fore in educational attempts to measure recollected knowledge in a single, discreet data point such as a right or wrong answer to a test question. In Dewey's view, it is not accurate to say a data point of this sort measures knowing, rather the most we can say of such a data point is that it is an indication of something that can more accurately be understood as possession of a recognized meaning—a prerequisite to the act of knowing. On this point, Dewey is quite clear:

But, recognition is not cognition. It is what the word implicitly conveys; *re*-cognition; not in the sense that an act of cognizing is repeated, but in the sense that there is a reminder of the meaning in which a former experience terminated, and which may be used as an acceptable tool in further activities. ... Recognition is a nod, ... not a knowing. (1958, p. 328)

In contrast to traditional measurements of knowledge, big data offers data points that can tell us something more closely related to what Dewey would consider to be a knowing. Indeed, taken in the aggregate and viewed along a temporal axis, big data offers evidence that could efficaciously be understood through the lens of Dewey's theory of inquiry. Instead of a single data point that might represent a traditional epistemological notion of knowing versus not knowing, big data details a process of inquiry—a process that, for Dewey, epitomizes coming-to-know. As Georges Dicker describes, Dewey's process of inquiry is "the process by which [we] seek and acquire knowledge. Very roughly speaking, it consists in doing something to objects and noting what consequences result—in experimenting" (1973, p. 192). In this, there is no "distinct *event* or *act* of knowing over and above inquiry itself" (p. 203). Rather, "Dewey's thesis with respect to coming-to-know is that this entire process constitutes the so-called 'act of knowing'" (p. 199).

This insight stands to be invaluable in interpreting big data, as it directs analytic attention to the process of inquiry as a whole. There is a risk in analysis to break things down so much into constituent parts that a sense of the whole is lost. Like many sources of evidence, big data is vulnerable to this type of dissection at the expense of the integrity of a unified whole. Given the significance and the complexity of the human process of coming-to-know, it is imperative that we retain this integrity as we work to better understand how this process works. In this, Dewey's theory of inquiry ought to be

indispensable in conducting analysis of this sort. Guided by interpretations of Dewey's inquiry cycle, we can put big data to effective use by mapping the stages of the inquiry process: (1) asking questions, (2) investigating solutions, (3) creating, (4) discussing discoveries and experiences, and (5) reflecting on new-found knowledge and continuing the cycle by asking new questions for further inquiry (Casey & Bruce, 2011; see also Pedaste et al., 2015). Thus, I propose that utilizing big data in conjunction with Dewey's theory of inquiry would open up a mode of research that would emphasize knowledge processes, directing our attention to the rhythmic flux of coming-to-know while maintaining the integrity of the process as a whole.

Dewey's Philosophy of Experience and the Precision of Big Data

At the same time that Dewey's philosophy stands to give meaning to big data by providing a rich interpretive lens, this combination of Dewey's philosophy and big data stands to advance philosophical research, too. Indeed, studying traces left behind in processes of inquiry has the potential to yield insight into what is perhaps the most complex aspect of the inquiry process: the experience of coming-to-know.

On the surface, it might seem that no matter the level of detail, big data will never get us as close to this experience as, for instance, poetry might. Hence, as A. C. Bradley has said, "an actual poem is a succession of experiences—sounds, images, thought—through which we pass when we read a poem" (Dewey, 1934/2005, p. 112). Yet, the edges dividing qualitative from quantitative blur in utilizing big data (Cope & Kalantzis, 2015a), as computer-mediated learning environments frequently contain data relating to an experience of learning that are amenable to both modes of analysis. And in this blurring, we also find the nexus in which philosophical inquiry emerges as an indispensable lens of interpretation.

It is fitting that we turn to Dewey's philosophy in this regard too, as Dewey's account arguably stands out the most in theorizing about the experience of coming-to-know. Experience is a crucial concept for Dewey. Indeed, it is no coincidence that the word "experience" appears in the titles of three of Dewey's most influential works: *Experience and Nature*, *Art as Experience*, and *Experience and Education*. For Dewey, experience is what results from interaction between self and world, or as he put it, "between a live creature and some aspect of the world in which he lives" (1934/2005, p. 45). Dewey's approach to studying experience is to carefully attend to its form—the "operation of forces" occurring in the transaction between self and world that carries experience forward. Properly understood, form is not a property of the organism or of the world, but is rather comprised of rhythmic "checks, resistances, furtherances, [and] equilibria" occurring between organism and environment that move an experience forward toward its own integral fulfillment. And if, following Elliot Eisner, "experience is the medium of education" (2002, p. 3), then we would do well to study form in experiences of learning in order to better understand how humans come-to-know.

Dewey attends closely to the experienced rhythms of falling in and out of step with the environment and he maintains that we learn and grow through this rhythmic flux. A basic example of this unfolding appears in the beginning of *Art as Experience* (1934/2005), where Dewey describes a gap between an organism and its environment that poses a potential learning opportunity in which, to use Dewey's language, life itself could be said to grow. Dewey explains that this gap could be something like a need for food or fresh air, but we can draw on this analogy and apply it to educational gaps as well, such as a gap in understanding, or the gap we experience in the process of writing when we can't

quite find the right words to express what we want to say. In moments of such lack, Dewey offers that we experience a demand, a need to reach out into our environment for fulfillment in order to restore equilibrium. In finding food to eat or the right words to convey our ideas, we “recover union” with our surroundings. In this, there is a significant moment of growth for Dewey because, “in a growing life, the recovery is never mere return to a prior state, for it is enriched by the state of disparity and resistance through which it has successfully passed” (1934/2005, pp. 12–13). Thus there is a moment of consummation that marks a transition point to a new mode of being in the world.

This describes a profound type of learning of which Dewey offers many examples throughout his philosophy. Although Dewey offered a number of contributions to the perennial quest for understanding the process of coming-to-know, the process of working to “recover union” is particularly significant for my purposes here due to the precision big data can offer in analyzing this process. Although big data cannot offer direct manifestations of rhythmic form because form is a property of experience occurring between self and world, big data does offer highly detailed traces of experiential processes of learning. By offering so much evidence in the way of traces left behind experiences of coming-to-know, big data opens doors for an unprecedented mode of analysis for understanding more about the form and rhythm of learning itself.

Big data offers an incredibly detailed transcript, if you will, that lends itself to a kind of historical analysis that makes it possible to see the micro-dynamics of the development of a learner’s thinking. This affords us an unprecedented way to investigate the experience of coming-to-know with empirical detail that is identifiable, assessable, and measurable. Indeed, big data enables the unprecedented benefit of a verifiable fine-grained lens in this intricate process. What insights might we glean from identifying the precise moment in the creative process in which the student initiates something new that leads to a “recovery of union”? Might it be possible to search back from this moment in order to see what contributed to this creative turn?

Picking up on a previous example, let us consider this creative turn to be a written idea, composed in digital space. Perhaps there would be some clues in the search history that may have sparked the new idea. What if we couple this with an analysis of the pattern of keystrokes, and a record of the exact timing evidenced in the activity log? This coupling of structured and unstructured data opens up an interesting and potentially significant view of the learning process. On their own, unstructured data such as timestamps and keystrokes are not semantically meaningful; that is, they are not self-describing in the way that structured data are (e.g., test scores, grades, or search terms). But by using structured and unstructured data in conjunction, we can employ self-describing, semantically meaningful data points alongside unstructured data that can tell us about the micro-moments of a learning process. In this, we can see more precisely how learners satisfy an impulse or interest by working it out, which involves “running up against obstacles, becoming acquainted with materials, exercising ingenuity, patience, persistence, alertness” (Dewey, 1902/1990, p. 37)—all of which can be recorded and investigated at the micro-level in the era of big data.

We might imagine the tempo and pattern of the key strokes in relation to how a work is coming together—as if, while a piece of writing is constructed, a piece of music is composed simultaneously in the rhythm of the key strokes. We might establish models of various types of keystroke patterns associated with different types of learning experiences and study patterns created at different phases of the project. What might this music sound like when the inquiry process is working well? What would it sound like when inquiry is falling apart? What precipitates a transition to a breakthrough moment? Are

there patterns that can be discerned across learners in studying the rhythm of this creative process? What might we learn from attending closely to this rhythm of transaction occurring between self and world? Whether or not this would yield significant results is an open question beyond the scope of this essay and would require analysis against existing datasets. My purpose here is to suggest that we stand to uncover new depths in understanding how this integral learning process unfolds by studying micro-level traces of this rhythm of interaction.

Although big data cannot be said to capture experience itself, it does allow us to capture micro-level traces of the learning process such that we have never before been able to see, let alone study systematically. Thus, big data offers a means of greater penetration into the question of how humans come-to-know through its affordance of richly detailed traces that are related to this experiential process.

Further Extensions

The more deeply we look into the philosophical literature, the more significant this line of inquiry becomes. Thus, as we read further into Dewey's discussion of this process of recovering union, we find that the question of how humans come-to-know becomes even richer when Dewey connects this process to our very selfhood. This opens our line of inquiry further by asking yet another perennial question—that of how humans come-to-be.

Extending his analysis of experience, Dewey tells us “[t]he self is both formed and brought to consciousness through interaction with environment” (1934/2005, p. 293). Thus, the rhythms of interaction that we are interested in studying closely in the learning environment with the affordances of big data are at the same time contributing to the development of self. “From the first manifestation by a child of an impulse to draw up to the creations of a Rembrandt, *the self is created in the creation of objects*” (p. 293, emphasis added). As we have seen, when objects are created through digital media, they leave behind micro-level traces of evidence that detail the unfolding of this process. In this way we can study this process of self-creation through its “demands [for] active adaptation to external materials,” which includes “a modification of the self so as to utilize and thereby overcome external necessities by incorporating them in an individual vision and expression” (p. 293). Big data allows us to trace these developments and study how the tiniest bits of rhythmic interaction eventually lead up to the development of a self. In this, we can glean both the macro-level view of the self along with the micro-level detail of which the self is constitutive. And whether this self be a Rembrandt or someone else, we stand to gain crucial insight into this process of human becoming.

This same line of philosophical reasoning can inform discussions that are much closer to the ground of educational practice too, by suggesting a crucial way in which big data stands to shift how policymakers and educators alike think about educational assessment (Cope & Kalantzis, 2015b). In an era of big data, we can more fully embrace the idea of knowledge as a process rather than a fixed cognitive state to be measured. With so much evidence in a readily analyzable form about the concrete product of complex knowledge work, the one-time measurement provided by a standardized test offers significantly less value. Rather, knowledge artifacts themselves contain evidence that can tell us about a learner's macro-level of functioning and also yield the benefit of a record of all of the steps taken in the creation of that product, which can offer insight into the precise ways in which a learner might benefit

from further instruction. Danielle Allen picks up on this idea in her recent philosophical analysis of education and equality:

The archive of materials generated by instructional practice already provides a remarkable treasure trove of data for seeing what and how students are learning and how teachers are performing. The challenge is to learn how to make use of all this already existing data to assess student achievement, evaluate teachers, and support continuous improvement. To do these things, we would need to gather data from assessment practices that are *part of* the craft of teaching itself, make what are often tacit internal standards of excellence explicit, validate the value of those standards through research, evaluate the gathered data against those internal standards, and use those evaluations to work on improving teachers' craft. (2016, p. 23)

Here, the distinction between formative and summative assessment becomes a matter of perspective, as the same data would inform both a prospective and retrospective analysis.

Whether we are considering how we might study the experience of coming-to-know, the process of self-development, or the more on-the-ground-of-practice type of analysis of educational assessment, all of these examples demonstrate ways in which philosophy of education and big data stand to fruitfully intersect. Furthermore, the fact that we can trace a direct line of philosophical reasoning from ephemeral concerns pertaining to the experience of coming-to-know all the way down to the nuts and bolts of how we might go about the business of educational assessment marks an exciting prospect for the field of philosophy of education. In linking these various philosophical inquiries, big data allows for new ways to connect perennial concerns of philosophers of education to the most practical affairs of everyday schooling. This suddenly unlocks potential for philosophical concerns to become more practicable. In this regard too, we would do well to engage with big data and help to shape education's rapidly unfolding future.

Conclusion

Moving forward, the need for philosophical contributions will become increasingly imperative for addressing thorny ethical, social, and political concerns related to data collection, government surveillance, national security, and cybercrime. Issues of personal freedom, autonomy, public safety, corporate behavior and profitability, international relations, and even war have now shifted to the cyber realm. In this, big data presents big challenges that will require coordinated, multi-disciplinary thinking to untangle. In the educational realm, as much as big data holds potential for unlocking a new empirical layer for understanding the process of coming-to-know, big data at the same time raises significant concerns pertaining to how the vast amounts of information collected will be used. Most of the time big data's uses are secondary; "that is, they are not the reason the data was collected in the first place. In fact, that's the basic promise of big data: save everything you can, and someday you'll be able to figure out some use for it all" (Schneier, 2015, p. 40). And with so much information being collected, this challenges the basic argument behind removing personally identifiable information such as a name or unique account number. "The more information someone has about you, even anonymous information, the easier it is for her to identify you. ... We either need to develop more robust techniques for

preserving anonymity, or give up on the idea entirely” (p. 53). Indeed, there is much about big data that philosophers can help to untangle.

As we enter the era of big data, there are crucial opportunities and challenges to be met. How will we channel the revolutionary capacity of big data? The stakes are high for answering this question across domains—and this is particularly true in the realm of education. In this paper, I have attempted to demonstrate ways that philosophers of education might fruitfully address this wide-open potential. In particular, I have considered ways that Dewey’s philosophy might contribute to empirical research engaging big data through his theory of inquiry, and explored how considerations of his philosophy of experience might benefit from the fine-grained level of empirical detail that big data affords. Moreover, tapping into big data’s potential allows philosophers of education to speak in more concrete ways about how individuals come-to-know, thus opening up new ways to make vital connections with educational practice. At the same time, big data poses significant challenges related to privacy and security that require technological expertise alongside expertise in human and social factors. Here, philosophers have an important contribution to make. In this rapidly unfolding era, I urge that we heed big data’s call.

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