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CAUSAL REASONING ABOUT EDUCATION

What Is It and What Should It Be?

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Key messages:

- Causal reasoning about education should privilege an intentional rather than a natural conception of causation.
- Education is namely a living ecology that can be conceptualized as an open, meaning-making, and recursive system.
- If we do not expect generalizable timeless laws, there is no replication crisis.
- We characterize education in terms of meaningful movement in motion, where different stakeholders have different positions, purposes, and potential.
- Educators and researchers have freedom in centralizing causal or becausal reasoning about educational processes, and we argue that any emphasis can have real consequences.

Key readings:

- Akkerman, S. F., Bakker, A., & Penuel, W. R. (2021). Relevance of educational research: An ontological conceptualization. *Educational Researcher, 50*(6), 416–424.
- Biesta, G. J. (2020). *Educational research: An unorthodox introduction*. Bloomsbury Publishing.
- Flyvbjerg, B. (2001). *Making social science matter: Why social inquiry fails and how it can succeed again*. Cambridge University Press.
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50.1 A dominant form of causal reasoning about education

Educational practitioners, parents, scholars, and policymakers would like education to "work," so that it supports learning and development in particular directions. Education has in that sense always been purposeful, which has implications for how it is researched (Akkerman et al., 2021). This chapter addresses causal reasoning about education, as practiced and avoided in the educational sciences. To clarify, we do not write about

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causality as a topic students learn about in, say, physics or history, but about how we as educational researchers struggle with the question of how educators can support learners to develop in a desired direction, and how to make valid claims about such processes. We acknowledge that causality is an umbrella term (D'Oro & Sandis, 2013)—one word for many things and processes (Cartwright, 2004; Illari & Russo, 2014). It can also be seen as an "elevator" word (Hacking, 1999)—one that can be used in a down-to-earth sense informing our everyday actions all the way up to a general philosophical level at which one may skeptically argue that causation does not exist at all (e.g., Russell, 1912; see Howe, 2011). The issue we address in this chapter is that our discipline of educational sciences seems to privilege a natural conception of causation rather than an intentional conception (Howe, 2011) or to avoid the topic altogether. Both positions are problematic, as we shall argue.

Philosophers have long discussed causality, yet as educational researchers with a strong interest in philosophy, it has been difficult—to say the least—to identify philosophical insights on causality that "apply" to our context (cf. Maxwell, 2007). One reason is that we do not have the preparation and resources to engage with technical debates (in, e.g., D'Oro & Sandis, 2013). Another reason is that the vast majority of the philosophical literature on causality focuses on the natural rather than the social sciences (with notable exceptions such as Howe, 2011. Maxwell, 2004). More fundamentally, however, we study a complex phenomenon, in which the five scientific problems related to causality identified by Illari and Russo (2014)—control, prediction, inference, explanation, reasoning—are intricately connected. In the first place, there is the issue of control: Teachers are expected to help students achieve particular learning goals and are often held accountable for the results. Second, education is future-oriented, so educational design and teaching involve prediction: Educators use particular strategies and materials that supposedly lead to desired effects and do so reliably (even though we criticize this predictive thinking later in this chapter). Third, inference is key in many educational practices such as assessment: Based on a sample of indicators, teachers, and researchers make inferences about students' current levels of understanding, interest, achievements, or about educational strategies more generally. Fourth, surprising or interesting phenomena ask for explanation (e.g., why did something fail?) in causal or "becausal" terms (Tanney, 2013). Fifth and last, reasoning about education is different from the natural sciences because teaching and learning are not just biological processes taking place in the realm of law but also human endeavors unfolding in the space of reasons (Bakhurst, 2011; Derry, 2013; McDowell, 1996). Inspired by Aristotelian thinkers, Howe (2011) emphasized that the social sciences need an intentional (teleological) conception of causation rather than a natural conception.

Besides the multifaceted complexity of these five scientific problems regarding causality in educational phenomena, another difficulty with learning from philosophy is that it has internal disciplinary boundaries between metaphysics, ethics, epistemology, etc. This compartmentalization makes it hard to do justice to the causal processes (e.g., learning mechanisms) at stake in the real-world phenomenon of teaching students. As educational researchers, we face ontological, ethical, epistemological, and methodological issues simultaneously—not only in questions about how to study education but also in thinking through how knowledge from our discipline can be relevant in use (Akkerman et al., 2021).

These philosophical issues are only superficially addressed in most of the educational research community, yet we see urgent reasons to pay attention to them. In light of its purposeful nature, the educational field has been dominated by an instrumentalist view which centers on what means reliably produce predefined outcomes. Teachers are to bring about these outcomes in their students by implementing empirically tested interventions, especially

in countries that have embraced so-called evidence-based policy (to which we will return shortly). Not surprisingly, the mechanistic causal reasoning borrowed from the natural sciences has been dominant in creating and evaluating such interventions, probably due to the appeal of its rigor and clarity of its claims (Kelly, 2004), which also makes for a compelling rhetoric in funding applications.

We can already see the problematic nature of the way the field tends to reason when looking at how we reason in everyday life (including teaching and learning). We experience ourselves as actors with purposes. Our actions are undertaken for reasons, grounded in values and our direct experiences. Whenever our actions are collective actions—such as those of a school deciding on a new policy, or a design team developing new instructional materials—the reasons we offer are not only explanations or justifications for our actions, they also reflect the deliberations that have led to these actions (implicitly working with an intentional conception of causation). We often spend ample time deliberating, because we understand the actions we take to be "consequential," that is, they matter for what follows. Our actions as educators enable and constrain subsequent action and as such have "effects" on students. This everyday perspective Kaplan (1983) once termed the *perennial* perspective on action, to mark that it recurs across multiple domains of practice and shows itself across many historical epochs.

An understanding of causality that relies on the perennial perspective is very different from that which guides experimental research in education. The idea behind common experimental designs in educational research can be summarized as follows: To identify a causal relationship, one would need to compare the outcomes from two scenarios, one where the cause of interest is absent and another, otherwise identical scenario, where the cause is present. A comparison of the measured outcomes is then used as an indicator of a causal relationship (for a discussion of this so-called *Potential Outcome Modeling* see Runhardt, this volume). The key aim of such experimental research in the field of education is to determine the effectiveness of particular educational interventions. Since educational situations can hardly be faithfully reproduced in a lab, experimental interventions are usually to be implemented by actors in real settings. Accordingly, the logic behind this approach recognizes that many other factors besides the treatment "cause" learning (or the lack of learning) and can therefore confound the results. To account for this, researchers set up Randomized Controlled Trials (RCTs). Here, confounding factors are randomly distributed across the experimental group, which undergoes the tested intervention, and the control group, which does not—similar to how treatments are tested in medical studies. RCTs are widely used as a tool to achieve an unbiased estimate of how effective a means the intervention is to achieve a certain end. Generalizability is key for such estimates to be deemed widely applicable. Therefore, context and history must be treated as background noise from which to estimate the desired effect. This effect then can be said to predict well how the intervention might be effective to populations (e.g., teachers and students) to which findings generalize (Tipton, 2014), rather than individuals (for causal inference on the individual level, see Rubin, 1974; for a discussion of levels of causality, see Danks & Harrell, this volume). After experimental conditions are artificially created and controlled, and the desired effects are statistically distilled and pinned down, the results of RCTs are interpreted to yield recommendations. From there on, it is up to individual educational actors (e.g., education agency leaders, teachers, tutors, …) to use the researchers' insights to decide what to do in their specific social, cultural, and material contexts.

Educational researchers generally agree that social phenomena are much more complex than natural phenomena (Berliner, 2002; Wieman, 2014) and that causal relationships in education cannot be expected to hold in the same way as in the natural sciences. It is therefore granted that there might be different kinds of causality upon closer look (for a discussion of

this, see Suárez, this volume). However, on the whole, this understanding remains implicit in the educational research community, and it is common practice to settle the issue as a lamentable methodological limit, where the complexity of educational phenomena is conceptualized as an almost infinite number of confounding factors (Collins et al., 2004), and where collective effects may not apply to individuals. It is important to acknowledge here that many proponents of RCTs are careful with or even critical toward making causal claims. Some point out that what they show are results of what "has worked," rather than "what works" (universally) (e.g., Higgins, 2020). However, in our eyes this ignores the actual consequences and uses of RCTs in the world of policy debates, as the reality of how RCTs are publicly received and widely implemented remains in the spirit of "what works": Results from RCTs by nature take the form of "X has an effect on Y," where X typically is a general description of an intervention (e.g., giving feedback, collaborative learning) as the independent variable and Y some construct (e.g., motivation, achievement) as the dependent variable. Given the expectation that these effects should be reproducible, as well as the intention that they should inform practice, it is hard to deny that they aim to tell educational actors how to make certain things happen. Call it "causation" or not, the expectation will be that "if X, then one can expect an effect on Y."

One way in which the experimental approach to causality manifests in educational practice is through so-called evidence-based policy (analogous to the idea of Evidence-Based Medicine, see also Anderson et al., this volume), which is adopted in several countries (e.g., What Works Clearinghouse in the USA; Educational Endowment Fund in the UK; NPO in the Netherlands; Danish Clearinghouse). Such policy transforms results from experimental research into rules for educational practice, with the aim of ensuring that successful interventions are widely implemented and thus improving education on a large scale. Evidence-based policy considers RCTs to be the gold standard of research in education to determine what works (National Research Council, 2002; Slavin, 2002). One of the statistical results of these trials, effect sizes, are interpreted as objective estimates for the effectiveness of the tested intervention (for a critique of this interpretation, see Simpson, 2019). Oftentimes, multiple effect sizes from RCTs of similar interventions are combined in meta-analyses, which are sometimes combined again (Hattie, 2012). Some funding agencies (e.g., the Institute of Education Sciences in the USA) privilege the use of RCTs when making funding decisions, and there are strong policy incentives for schools to adopt evidence-based programs, both at the federal level and state level (Haskins & Margolis, 2015). Additionally, educational researchers are expected to make an (ideally measurable) impact. All these are examples of a prevailing technical-managerial approach to accountability in the educational field, which reflects an instrumental (typically linear) model of causality that focuses on identifying instrumental means (interventions) that reliably lead to (cause) better outcomes or effects (increased scores on standardized tests) than otherwise would have been. This trend is propelled by noble intentions: In a society where evidence is expected to function as the arbiter to guide decisions (rather than, say, political preference), and especially in an area with stakes as high as the educational field, it is understandable that decision-makers long for tested success recipes.

Many philosophers and social scientists have pointed out the inadequacy of such natural-causal thinking about education (e.g., Biesta, 2007; Cartwright, 2019; Olson, 2004). A key critique has been that educational practice is too complex to be understood in terms of input, process, output models that aim to reproduce certain target outcomes "in" students. A more fundamental point is that such models are based on an understanding of causal relationships as generalizable laws. As such, they essentially—and mistakenly—treat people as neutral objects whose movements can be predicted and controlled from the outside to be steered in

predefined directions, as though they were inanimate matter (Biesta, 2021; Smedslund, 2009). Dunne (2005) wrote: "The ideal to which [such] technical rationality aspires, one might say, is a practitioner-proof mode of practice" (p. 375). However, students and teachers are living, breathing, wishing and hoping, dreaming and dreading, becoming beings, historically informed, and anticipating the future, and thus "can as much comply to as disregard or oppose what they are offered or expected to do" (Akkerman et al., 2021, p. 419). Or, as Flyvbjerg (2001) pointedly stated: Humans talk back, that is, they can act on information and change their actions, including information from an RCT. For the same reason—neglect of subjective experience and agency—the causal models previously discussed do not take into account the free action involved in the various subjective phenomena that are at stake in education (Biesta, 2021): moral decisions, deep individual struggles, vague or fleeting emotions. Aspects of practical rationality (see Dunne, 2005, on phronesis) and experiences such as these are difficult to define and measure, let alone reproduce.

An alternative approach to the dominant causality approach has been the stress on the idiosyncratic nature of social phenomena (Hammersley, 2014) along with a move toward qualitative research and case studies in particular (Salvatore et al., 2013). Given this idiosyncratic nature, several scholars have argued against the use of variables altogether (Toomela, 2008, 2010) or simply refrain from using causal terms and making causal claims (Guba & Lincoln, 1994). Packer (2017) prefers to speak in terms of constitution and constitutive relationships.

Although we understand the decision to avoid causal language and sympathize with its reasoning, we face the reality of a wider problem: The mechanistic understanding of causality holds an unspoken position of epistemic superiority in educational research. This perpetuates a hierarchy among educational research approaches: Those which are suited for and interested in making the kind of causal claims that emulate the natural sciences, enjoy more respect and funding than those which are either unsuited for or disinterested in this particular form of causal reasoning. "Alternative" research approaches such as in-depth qualitative or participatory studies are marginalized as "second-class" science incapable of identifying "real" (read "generalizable and reproducible") causal relationships. Per contra, large-scale quantitative research has a higher status in policy, public attention, and in the academic community. Avoiding the use of causal reasoning altogether in other forms of research seems to bow to this hierarchy, as if saying: "if I cannot make causal claims in the style of natural science and RCTs, I better not make causal or becausal claims at all." We believe that this is throwing out the baby with the bathwater. To be specific, what is thrown out is the actualizing power that causal claims hold: "If you do X, you can make Y happen" is a claim that calls the reader to action, promises potential for desirable change. In Howe's terms, this would involve an intentional (teleological) rather than a natural conception of causation. To omit this call can mean to weaken the perceived applicability of one's findings in the eyes of policymakers and other educational actors or researchers. This means that how we understand causality when we think about education is more than just a matter for philosophers. It matters for research practice, for the interpretation and reception of findings, and, not least through evidence-based policy, affects educational practice.

This leads us to the appeal that is the heart of this chapter: Educational researchers need to face the lurking questions of what role(s) causal reasoning can and should play in their work, what kind(s) of causes they study, and what kind(s) of educational practice they enable or constrain through their views on these questions. For that purpose, we need the philosophical community to join the conversation (e.g., Howe, 2011; Maxwell, 2004) more actively and also more pragmatically, in a manner that is accessible to educational researchers without a philosophical background. For an interventionist, future-oriented domain such as education,

interdisciplinary dialogue is vital (Bakhurst, 2023): Educators need heuristics on how to make decisions in education and support learning toward particular goals and in line with particular values. What we have already learned, as mentioned, is that educational research is not a purely epistemic practice and that its intertwined ontological and ethical dimensions deserve much more attention (Akkerman et al., 2021; cf. Barad, 2007). Hence we see the need to reflect more deeply on the special nature of education, its role in the world, and what this means epistemologically and methodologically. As input for such broader discussion, the following sections form a brief overview of some of our contemplations.

50.2 Views on the ontology of education and implications for causal reasoning

Education has a special position between the private sphere of home and the public sphere of society (Arendt, 1994). Etymologically, the Latin *educare* means to train or mold; *educere* means to lead (duc-) children out (e-) of their homes into the broader society—two meanings that have to be balanced in the view of Bass and Good (2004). People learn in multiple ways and places. School is a very specific pedagogic form (Masschelein & Simons, 2019) of "free time" (the original meaning of the Greek *scholè*) for study rather than work (read child labor). Several educational thinkers have raised the question of what the purpose of such study is. Bakhurst (2011), for example, settles on autonomy as the purpose of education—the ability to think freely and develop the skills to shape one's life and the world more broadly in a meaningful way. In the current time of interconnected ecological and humanitarian crises and injustice, we would privilege care for and in the world as a meaningful purpose.

Returning to what we have earlier described as the purposeful nature of education, Biesta (2021) proposes that education has the following, sometimes conflicting aims: qualification, socialization, and subjectification. The order in which they appear here is the most commonly assumed in today's public discourse: The purpose of education is understood primarily to prepare young generations professionally so they may enter the labor market successfully (qualification), secondarily to introduce and accustom them to the ways of living we have developed as humans in this world (socialization), and lastly, to support their growth into self-standing adult subjects who can act responsibly in the world, saying "yes" to some and "no" to other forces acting on them (subjectification). As such, the purpose of subjectification inherently rubs with the fact that most educational systems run on a curriculum that prepares students for a particular endpoint, usually exams. This structure implies that education is a form of long-term intervention where multiple stakeholders such as the government, higher education, labor market, and parents have a say in what students ought to learn. Each of these stakeholders have their own logic related to their positions, purposes, and the potential they see at that moment, which makes education "polylogic" (Akkerman et al., 2021), and hence subject to many forces.

Biesta (2020) further considers education systems to be "open, semiotic, recursive systems" (p. 39). All three terms have implications for causal reasoning about education. First, educational systems are *open* because students participate in other practices such as spending time with their families and other societal activities, and as has been widely acknowledged by now, learning takes place across all of these interrelated realms (e.g., Bronkhorst & Akkerman, 2016). Hence, what we do in schools cannot be considered causal factors in isolation from the rest in the same way that one might isolate causal factors in the closed system of a physics experiment. But the issue with causality goes beyond mere methodological challenge, as the second term shows: like other human and social systems, education systems are

semiotic, in that they are based on intentional (inter)action and communication as opposed to a "physical push and pull" (Biesta, 2020, p. 39). To put it in Sellars' (1997) and McDowell's (1996) terms, education does not take place in the realm of law (such as the orbit of comet Halley), but in the space of *reasons*. Thus education cannot be properly understood in purely natural causal terms, since reasons are normative: Their framing and the way they are weighed in decisions and arguments are made in light of human values and aims (Brandom, 2000; Derry, 2013). Third, education systems are *recursive* in that various elements such as students and teachers are sense- and meaning-making agents who shape the system and are shaped by it.

Inspired by what educational thinkers since Dewey and Vygotsky have written about the nature of education, we have characterized its ontology in terms of two phrases: *meaningful movement in motion* and *position, purpose, and potential* (Akkerman et al., 2021):

> We propose that what is key in the ontology of education is the human and natural world as it is and is becoming. Educational research is concerned with an ontology in motion—with transitions over time, which can be as small as learning a new word, as long and wide as collective development of practices across generations, and as large as a global transition to online education due to the outbreak of a pandemic. The meaning of such transitions resides in people's own movements. These movements are defined, more specifically, by people acting from particular positions in the world (e.g., an institutional position as student or teacher) with certain purposes defined by themselves (e.g., as students wanting to become a doctor) and for them (e.g., by educational standards) with emergent potential in the future.
>
> (p. 417)

What does such changing polylogic ontology imply for causal reasoning? And how prominent should we want to make certain kinds of causal reasoning in and about the educational context, if by principle of process and development, education continually generates new conditions and new purposes? Methodologically, this ontological view would plead for a focus on actuality and generativity rather than on generalizable, ahistorical laws independent of context (cf. Pawson & Tilley, 1997). When we generate findings from causal inference studies, human beings can act on them in ways that change their utility for the future (see, e.g., Lemons et al., 2014). The principle of actuality recommends educational scholars and practitioners asking: What happens and what matters now? The principle of generativity stimulates one to ask: What potential can now be actualized in the light of the current purposes that educational stakeholders have? One implication of our ontological view and giving up the assumption of generalizable laws is that there is no replication crisis.

Instead of searching for generalizable laws, a key question becomes how desirable forms of learning ecologies (cf. Bronfenbrenner, 1979) can be promoted. In the next section we argue that it matters how we reason about education and then turn to a metaphor to elaborate on what an alternative way of thinking about causality might entail.

50.3 It matters how we reason

To be clear: We do not deny that natural-causal processes play a role in educational phenomena and are therefore relevant to how we research and think about education. Disciplines such as cognitive science and neuropsychology have provided useful insights into what can be called the biology of learning, which operates on molecular and cellular levels

where natural-causal mechanisms might well be at stake. To name a few examples, memory is consolidated during a particular phase of sleep, and this means that students' sleep is important to learning (Klinzing et al., 2019). Children need breakfast so they can concentrate because low blood sugar hampers the functioning of the brain, which largely uses energy from glucose degradation (Dienel, 2019). There are noticeable individual differences which matter for teaching and learning. For instance, when students face physical challenges such as visual impairment, they cannot participate in particular modes of learning that are widely used while in turn being more perceptive in other ways that most students would not be. Students diagnosed with labels of neurodivergence usually bring other challenges and strengths to the classroom than "neurotypical" students. It can help teachers to be educated about such differences and aware of how they may want to reconsider their assumptions about students' experiences and hence also their habitual ways of teaching. For such purposes, naturalistic causal reasoning is a precious means for improving our understanding of what is happening, so we can think about what matters in light of that and align our actions accordingly.

But, as Derry (2020) argues, it is a serious misjudgment to model education systematically on the basis of a biological construct so narrow as cognitive load, without putting that construct within the wider, complex, and dynamic entanglement of real-life educational situations. Such modeling is a symptom of overly applying linear causal and mechanistic thinking in trying to emulate the natural sciences (cf. Flyvbjerg, 2001; see also Danziger, 1997). Therefore, instead of treating all matters around students' learning and development as naturalistic, we agree with philosophical arguments such as those inspired by McDowell (1996): What people develop through education is "second nature," the ability to navigate the space of reasons—intricately connected with their "first nature" (biological bodies in the realm of law).

This brings us to the main message of this chapter. It matters how we reason in our educational decision-making—whether we privilege causal reasoning as if thinking about a mechanistic ontology, or value-driven means-ends relationships in a space of reasons (cf. Bransen, 2021). However, neither can be quite as black and white as this "either-or" formulation might imply; a great deal of nuance is needed in how we attend to our reasoning in educational questions. For instance, Biesta (2020) conceded that education is at least partly structured by (quasi-)causes. It requires buildings and education materials which influence teaching and learning, as the reader may know from the difference between spending time in a room with mobile, grouped tables, as opposed to a room with rows of chairs screwed to the floor, or a building with and without functioning Wifi. However, Biesta also warns against an educational system that is governed by causal thinking. We agree with him that it is possible to some extent to control teaching and learning, but doing so comes at a price. What will suffer are core values of education such as democracy, autonomy, care, equity, and freedom. To examine, safeguard, and manifest these values, we must address the question of how we can and want to reason about education, which returns us to our request that philosophers, practitioners, and researchers of education join forces in thinking together about this. One way to fuel such dialogue is to explore a metaphor including its strengths, limitations, and multiple interpretations.

50.4 A farming metaphor

In the Netflix documentary *The Biggest Little Farm* (Chester & Monroe, 2018), two buyers of Apricot Lane Farm (214 acres, 40 miles north of Los Angeles, USA) are shocked by the dead soil of their new home. Like the neighboring farms, the land had been used to cultivate

monocultures (e.g., lemons). These farms are typically efficient and effective, due to the tight control of conditions and precisely measured inputs (water, light, nutrients,…), faithful to tested success models for maximizing harvests. The Apricot Lane farmers, however, had a different ideal of what constitutes healthy life and quality farming. In the course of several years, they went on to diversify and stimulate the development of a teeming ecosystem. They faced many pests (snails eating the leaves, sparrows eating the fruit, coyotes killing the chickens), but over time, they found a way to work with(in) nature rather than control it. The various interconnected organisms, under the attentive supervision of the farmers, found their ways into a dynamic equilibrium in the sense that fewer extreme pests occur red. The ducks ate a good portion of the snails, birds of prey limited the numbers of sparrows, and coyotes ate the gophers rather than the chickens. When an immense amount of rain fell in a short period, the soil soaked up most water into the aquifer, while surrounding farms saw their surface soil being washed away to the ocean. What initially seemed a pest, such as the gophers, badgers, snakes, and weasels, proved a blessing in the long run as the activities of these diverse life forms enriched the soil with air and microbial life. The Apricot Lane way of farming entailed patience, knowledge, and attentiveness, active care for the flourishing of life without too much interference—a fine balance that was guided by a shift from a variable-controlled and outcome-oriented to a value-driven way of working. In the long run, this brought forth a healthier, more resilient, and flourishing ecology and, in the words of the farmers, a more meaningful experience of life.

This metaphor portrays how one can try to control nature relying mainly on a natural conception of causation or dialogically work with(in) nature privileging an intentional conception of causation. Similarly, one can try to control education or work with(in) education. These two approaches seem to each operate (even if implicitly) with their own perspectives on causality. The first that we reviewed, analogous to the monocultural farming approach, typically assumes there to be causal processes that can be modeled in terms of variables, and this knowledge is used to control outcomes. Effectiveness and efficiency are important criteria in such an approach. The second that is implied by the new owners' way of farming, Apricot Lane does not deny that natural-causal processes take place, but they emphasized the importance of a healthy soil and a meaningful life as something they kept striving for. We see a parallel with acknowledging the open, semiotic, and recursive nature of education and privileging the normative dimension of learning and teaching (an intentional conception). Working with education thus implies awareness of the changing nature of education (meaningful movement in motion) but also the multiplicity of the various logics that come with the positions that people in education have with multiple, sometimes conflicting purposes. Making education function well thus requires a complex weighing of reasons, and insight into what helps learners and teachers to realize the potential they see in light of their purposes. This is what working *with* the nature of education may entail. In practice, educators may, for example, adopt approaches such as culturally responsive pedagogy, use so-called funds of knowledge from the students' communities, or adapt curricula according to students' interests.

Thus as human beings we have the freedom to organize education with emphasis on particular kinds of causes (mechanistic, "becausal," constitutional, …), a choice that actualizes certain potentials more than others. As the Apricot Lane farmers show, approaching a complex ecology with emphasis on values, norms, and purposes implies a fundamentally different way of engaging with the agencies at stake. We believe that their example provides a helpful metaphor that can serve as a heuristic to expose aspects of education that are too often neglected: A scientific account based purely on "efficient causes," in Aristotelian terms, cannot do justice to the complex and interconnected phenomena under consideration (including

formal, material, and final causes). Both farming and educational practices have their own dynamics and rationality (cf. Dunne, 2005). So any intervention, to be fruitfully and sustainably integrated in these unfolding dynamics, needs to take account of that ontology. Put bluntly, educational actors as much as farmers are not intervening into a vacuum but into a living ecology which already has its own integrity.

50.5 Conclusion

To some extent, educators may well be able to realize particular aggregate outcomes by applying scientific findings of causal relationships in educational processes, just as farmers are able to draw larger harvests of a desired crop from a given patch of land if they apply scientific knowledge on how to maximize produce. However, the point we have argued in this chapter is that using educational research to exert control over teachers and students in this manner runs against ontological and ethical dimensions of education (Akkerman et al., 2021; Biesta, 2020; Nzinga et al., 2018). The question we have asked in the present chapter, hence, is not whether we *can* successfully predict and reproduce particular phenomena through mechanistic causal reasoning. Instead, the question we have addressed is whether we *should* do so. We have highlighted that mechanical causal reasoning in educational research manifests in objectifying (possibly dehumanizing) discourse in scientific recommendations and a technical-managerial approach to educational practice. We have further asked how we could and should reason differently about education and causality. To that purpose, we have conceptualized an ontology and ethics of education that foregrounds the dynamic nature of meaning-making in a changing world and our positions and purposes in it.

Although there is much more to be said about the parallels between the different farming approaches and educational approaches, let it suffice to close by saying that we see wisdom in the regenerative, sustainable farming promoted at Apricot Lane Farm. It holds a core lesson for how we could think about education: If we pursue education as a dynamic ecology and teleological ecosystem (cf. Bronfenbrenner, 1979) that aims to actualize values such as autonomous and creative thinking, freedom, and care for the world around us, then we need to privilege intentional-teleological over natural explanations of causation in our decision-making. The question we want to pursue and invite the reader to engage with is how the discussion on causal and becausal processes in education can best be continued.

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