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Enactive Design-Based Research in Vocational and Continuing Education and Training

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Abstract

The purpose of this article is to introduce a design-based research (DBR) approach developed in the field of vocational and continuing education, which is grounded in a pragmatic and phenomenologically inspired enactivist approach to activity. As a design-based methodology, our activity-centered and enactive DBR approach aims to generate knowledge related to design and to identify relevant design principles. After detailing the particularities of an activity-centered and enactive DBR approach, we focus on the results pertaining to design knowledge by identifying two broad design principles for vocational education and training, and five enactivist inspired principles for training design. A significant practical implication for researchers and practitioners in vocational and continuing education and training is that these enactivist inspired design principles provide promising pathways to enhance the connectivity between (i) work experiences, (ii) work and training practices, and (iii) learning contexts.

Keywords Enaction · Real-world Practice · Activity · Training Design · Curriculum Development

Introduction

A classic question in vocational and continuing education and training is the following: Which scientific research is useful to practitioners? In other words, which scientific research can really help them in practice while deepening our understanding of the practices and learning in these educational settings? Guaranteeing consistent and workable scientific outputs is not easy. Researchers face a persistent tension or dilemma between practical relevance and rigorous analysis (Argyris, 1980). The quest for rigour sometimes leads to reductionism, phenomenal oversimplification, and a focus on a theoretical gap too loosely coupled to practical issues. Yet the quest for practical relevance (or practicality) sometimes leads to ill-defined problems,

Extended author information available on the last page of the article

fuzzy concepts or objects, and investigations without theoretical foundations and epistemic justification. Faced with this problem, researchers in the training and learning sciences (including vocational and continuing education and training) have long been working to renew the relationship between research and practices. The design-based research (DBR) approach has sometimes been suggested as a solution for transcending “*the discontinuation between science education research and praxis*” (Juuti & Lavonen, 2006, p. 54). Too little attention has nevertheless been paid to DBR and its potential in the field of vocational and continuing education (Gerholz & Wagner, 2022; Leeman & Wardekker, 2011). However, we assume that it plays an important role in this field by creating and extending knowledge “*about developing, enacting, and sustaining innovative learning environments*” (Design-Based Research Collective, 2003, p. 5) that prompts the development of (new) “*theories or prototheories of learning*” (Design-Based Research Collective, 2003, p. 5).

Design-Based Research in Learning Sciences: A Brief Overview

Design experiments and the DBR approach were introduced and popularized in educational research by various researchers three decades ago (Barab & Kirshner, 2001; Brown, 1992; Cobb et al., 2003; Collins, 1992; Design-Based Research Collective, 2003). This approach is now well known and has given rise to an extensive literature (e.g., Anderson & Shattuck, 2012; Bakker, 2018; Bell, 2004; McKenney & Reeves, 2013; Wang & Hannafin, 2005; Zheng, 2015). It was developed by educational psychologists, who—questioning the limitations of laboratory psychology experiments for improving educational practice—developed alternative forms of experimentation. Their ambition was to contribute to (i) advancing fundamental understanding and (ii) strengthening educational practice, which remains the two-fold goal of DBR studies today. DBR differs from other interventions because (i) it shows a constant impulse towards connecting design with existing theory and empirical results, and (ii) it has a strong commitment (and likelihood) to generating new theories (not simply testing existing theories) and knowledge about design. As Barab and Squire (2004) noted, DBR is not a single approach but rather a series of approaches, with the intent of producing new theories, artifacts, environments, and practices that account for and potentially impact learning, development, and training in naturalistic settings. Wang and Hannafin (2005) defined some of the principles and characteristics of DBR. Seven characteristics have been retained and detailed: pragmatic, grounded, interactive, iterative (study-design-enact-study), flexible, integrative, and contextual. Let us add here that DBR studies are based on a strong standpoint: the learning sciences are sciences of the artificial (Cole & Packer, 2016), whether or not the use of technological solutions is envisaged. For Cole and Packer (2016), DBR in the learning sciences must cope with a twofold artificiality, as the environments in which designs are implemented are already artificial. This implies, of course, “*rethinking the things*” (Fenwick, 2010) and studying the role and functions of materiality and how every educational practice is affected by material. Most importantly, the learning sciences should also be sciences of design. As pointed out

by Simon (1996), what is necessary for researchers is not simply to design but to “*move towards research on the process of design*” (p. 113).

Toward Enactive Design-Based Research in Vocational and Continuing Education and Training

The purpose of this paper is to describe a DBR approach developed in the field of vocational and continuing education and grounded in a pragmatic and phenomenologically inspired enactivist approach to activity. Although it remains largely unknown, we consider that the enactive paradigm might generate fresh insights not only into vocational and continuing education and training (e.g., Fenwick, 2000; Viktorelius & Sellberg, 2022) by focusing on the embodied, embedded, and distributed nature of professional knowing and learning, but also into DBR studies. The originality and added value of our DBR approach lies in the interweaving of two concepts, *enaction* and *activity*, or to be more precise, in the engagement with *activity-as-enaction* in design-based research. After detailing the particularities of our enactive DBR in vocational education and training – especially the enactive view of knowing, learning, and training – we focus on the advances in design knowledge by providing promising design principles developed through our studies.

The approach and design knowledge presented here synthesize nearly two decades of research in vocational and continuing education and training in a multitude of professional contexts, with a focus on service work and/or caring professions (including education), industry, and security-related jobs. The studies have led, for the most recent example, to the design of VR-based training situations for nuclear power plant operators (Drakos et al., 2021), a video-based training platform for training X-ray technicians (Schot et al., 2019), a video-based training platform and a horse-drawn carriage simulator (Secheppet & Leblanc, 2021), a video-based training platform supporting the initial training and professional development of teachers (Leblanc & Ria, 2014), and art-mediated educational practices (Salini & Durand, 2020), while producing scientific results on learning and training. These multiple studies conducted for almost 20 years in various professional contexts, always coupled with design in real-world settings, constitute the strong empirical and practical background of this article.

Researchers contemporary of our time have developed approaches and formulated proposals that resonate and converge with our studies, while remaining historically foreign to our own scientific and design advances. We can regret it, but every cloud has a silver lining. This ex-post convergence reinforces the relevance and validity of our respective proposals. In particular, we are thinking here of *Embodied design* framework which has been axiologically and pragmatically concerned with schools (and to a lesser extent with the learning of physical skills) (e.g., Abrahamson, 2014; Abrahamson & Trninic, 2015; Abrahamson et al., 2020, 2022). If differences were to be listed, we could say that the *Embodied design* framework differs from our work by a) its very specific roots on radical enactivism and ecological dynamics, b) its restriction to school settings and to very specific learning situations (which also raises the question of representative learning and training design), and c) its non-use

of the concept of activity despite the importance given to sociocultural practices and ecologies.

Engaging with “Activity as Enaction” in Design-Based Research

As pointed out by Barab and Squire (2004), a core element characterizing DBR is its intent to understand “*the messiness of real-world practice, with context being a core part of the story and not an extraneous variable to be trivialized*” (p. 4). Activity, as a phenomenon and as a concept, plays a pivotal role in our enactive design-based research in vocational and continuing education and training. We recognize activity not only as that which must be the subject of particular interest in DBR, but also as a powerful lens for studying learning and for training design. Focusing on activity as phenomenon means, as claimed by Barab and Squire (2004), focusing on the detail of everyday life and on “what actually happens” in the messiness of real-world practice (Licoppe, 2009). The starting point is that there is a large gap between practice-as-imagined (work-as-imagined) or between practice-as-commanded (work-as-prescribed) and the everyday lived reality, and thus what is sought are means to bridge the gap by engaging more deeply in the empirical details of everyday life on the ground. In our DBR approach, activity is not just a phenomenon to be documented, but also a perspective and a concept. This means that we focus on the details of everyday life but do so through an activity-theoretic lens. The term activity frequently carries a broad and somewhat ambiguous connotation, or in reference to the Activity Theory (Engeström, 1987), a considerably narrower interpretation. Many theories have contributed to framing an activity oriented field of research, and they may be irreducible to a single theory. In our approach, we give an enactive inflection to the concept of activity.

Four points characterize our enactive perspective on activity:

- Activity is both an effect and a decisive building block of the asymmetrical structural coupling between an actor and its environment. Activity must be apprehended itself as an inseparable “actor–environment” whole. Activity is the manifestation of a relation of co-dependence in which the actor-pole side and the environment-pole side are related and combined into a whole—yet they remain distinct. Activity cannot be reduced to the properties of either of its two constituent poles. As brilliantly summarized by Varela (1976), they are “*not one, not two*”. But, as Di Paolo (2005) said ‘*Activity, like perspective, is an asymmetrical concept*’ (p. 443). Actors are capable of adaptively regulating their coupling with the environment. For Barandiaran et al. (2009), ‘*an agent as a whole drives itself, breaking the symmetry of its coupling with the environment so as to modulate it from within*’ (p. 370). Thus, an agent is a system that systematically and repeatedly asymmetrically modulates its structural coupling with the environment.
- Activity is embodied. Activity, as cognition, “*depends upon the kinds of experience that come from having a body with various sensorimotor capacities*” and “*individual sensorimotor capacities are themselves embedded in a more encompassing biological, psychological, and cultural context*” (Varela et al., 1991, p.

- 173). The term embodied action emphasizes “*that sensory and motor processes, perception and action, are fundamentally inseparable in lived cognition*” (p. 173).
- Activity is lived. It is always accompanied by and gives rise to first-person lived experience. In our research, we refer to a particular form of consciousness, which we call pre-reflective consciousness, i.e., a familiarity with oneself that accompanies living situations. Pre-reflective consciousness is regarded as the cutting edge of the living process itself and as the surface effect of the asymmetrical structural coupling between the actor and the environment (Poizat et al., 2023).
 - Activity is semiosis. The enactive view is that living beings are fundamentally sense-making creatures that bring forth (enact) meaning in their asymmetrical interactions with their environments (e.g., Froese & Di Paolo, 2009). A living organism enacts the world it lives in. Activity is then a meaningful and relevant navigation, and a continuous “instauration” of meaning (Latour, 2011 p. 311).

Activity and enaction are like prisms that transforms everything that flows through it, enabling new observations and explanations. Engaging with “activity as enaction” in DBR allows us to address real-world practices as a deeply embodied and embedded integrated whole. Activity becomes what a given actor “does” as a living, embodied, culturally embedded, and lived unit engaged in a sociocultural practices and ecologies (including indiscriminate actions, thoughts, sensations, perceptions, attention focusing, intentions, emotions, expectations, and interpretations).

An Enactive Perspective on Knowing, Learning and Training

Knowing and Learning

To begin with, four important elements need to be mentioned here. Firstly, knowing happens between knower and known. It takes place in a continual becoming of both knower and known, and must be approached as a transformation, for both knower and known and for their relation. There is a dialectical balancing between the being of the knower and the being of the known. For De Jaegher, (2019): “*the process, events and beings that the knower knows balance between being themselves and being-as-they-are-known. That is: they are determined in part by themselves (their own being) and in part by the knower’s being (her situation, motivations, interests). They are never fully self-determined, and never fully other-determined—always dialectically evolving between determinations*” (p. 859).

Secondly, at each instant, (i) a living being produces knowledge, i.e., a transformation of its coupling with the environment, and (ii) the knowledge produced is both the result of past (or immediately preceding) coupling with the environment and the transformation of a structure of anticipation. However, let us emphasize that the notions of autonomy and coupling transformation—although decisive—are not sufficient to embrace learning. First, an agent is capable of adaptively modulating the coupling between itself and the world. This ability to modulate the structural coupling is both learning and the process leading to learning. Secondly,

agents modulate their coupling with the environment following certain norms that belong to or have been adopted by the agent itself. Here are the three requirements for agency identified by Barandiaran et al. (2009): self-individuation, interactional asymmetry and normativity. As mentioned by McGann (2014), “*this description of agency as being a modulation of the coupling between the agent and its environment means that agency is not something that occurs within the agent. It is, rather, something that emerges in the interaction between the agent and its environment*” (p. 219). The third requirement, normativity, is also not trivial when it comes to learning. The normativity that is required for agency does not exist wholly within the agent, but is distributed through the environment in which the agent is acting, in its physical, social and cultural aspects (McGann, 2014). It is not something that resides within individuals, but something that exists in contexts more broadly. Rietveld (2008) talks about situated normativity. Learning is in part defined by their normative character. For Récopé et al. (2024), an enactive perspective on learning and training must necessarily consider the relationship between the agent’s “own norms” (or locally prevalent activity norms) and extrinsic norms (or valued cultural norms). Learning becomes a modulation of the structural coupling to better satisfying the agent’s current own norm (or locally prevalent activity norms), and transformative learning or development a modulation of the structural coupling with the emergence of an agent’s new own norm (or locally prevalent activity norms). It then remains for trainers to determine whether training should encourage conventional or non-conventional learning and development, i.e. whether or not it should be in accordance with the valued cultural norms. In the first case (and only in this case), the challenge will be to find training design principles that are likely to make valued cultural norms desirable and appropriable by the trainees.

Thirdly, the definition of cognition as embodied action is an alternative to a view of cognition as the representation of a world that is independent of our perceptual and cognitive capacities by a cognitive system that exists independent of the world. By extension, knowing is not representational (i) in the sense of being an elaboration, a manipulation or a retrieval of symbolic, abstract generalities, computational, or action-neutral mental representation of a pre-given world, or (ii) in the sense of being functionally isolated from action or from the embodied engagement in the world (McGann, 2018). There are clearly many different ways of knowing and the enactive approach encourages us to look at its wide variety. De Jaegher (2019) insists that we should not restrict knowing to symbolic, computational, and algorithmic knowing. This has two implications: not to focus solely on abstracting kind of knowledge, but also not reducing human knowing to an abstract understanding of the world around us (McGann, 2018). De Jaegher (2019) points out that, in trying to understand our highest capacities, cognitive scientists aim to explain things (sometimes hastily) like mathematics, language, and planning. This raises a much more fundamental question according to De Jaegher (2019): “*Are these really our most sophisticated forms of knowing?*” (p. 847). For her, our most sophisticated knowing is full of uncertainty, inconsistencies, ambiguity, and contradictions. She adds “*The engaged knowing that I consider the highest form of human cognition is not this abstracting kind of knowledge, which in any case is derived from it* (De Jaegher, 2019 p. 862).

In our studies, knowing and learning were approached through the notions of type, typicality and typification, as they were used by Schütz in his phenomenological sociology (which differs from Husserl one's in two ways: its pragmatic direction and its semiotic turn). With these notions, it is possible to escape from a strictly symbolic, abstract, computational, and algorithmic view of knowledge and to give an account of the whole spectrum from "symbolic" to the more organic and sensorimotor knowledge ("non-symbolic" or "prelinguistic"), simultaneously both cognitive and affective. Knowing means being in a situated capacity to re-enact types (or schemes of experience) and their relationships. Learning becomes a typification of the coupling transformations or modulations, and of the lived experience associated with it. Learning could lead to a reinforcement or weakening of typicality of certain types, to an expansion and creation of new types and relationships between types, or to a cosmological revolution and dramatic shift of existing types or relations between types. We assume that types, typicality and typification are the most basic and sophisticated form of learning, and are the first building block of any other form of learning which is necessarily derived from them.

Here-and-now activity is characterized by singularity and contingency, but also by "recall" of past experiences (or past actor-environment couplings) and anticipation of the future. That is why we assume that activity is constantly accompanied a) by the reactivation of established schemes of experience that are partly "proper to the actor" and "partially consensual", b) by typicality judgements and typification of phenomenal configurations. The possibility of recalling typical features in past experience (to be approached as *potential*) is correlated with the possibility of anticipating typical features in future experience (to be approached as *virtual*). Typification consists in syntheses of identification and recognition that "reduce the unknown to the already known", or that create new regularities. It is inseparable from typicality judgements. Typifying means 1) synthesizing – minimizing part of the plurivocity of the original experience, and 2) inserting this product into a constellation of syntheses already achieved (Cefaï, 1994). Types are the result of this constant process of producing typicality judgments and typifying phenomenal configurations, through which an actor recognizes "family resemblances" between singular experiences (or between various coupling situations). As schemes of experience, types can refer to all dimensions of lived experience: every actor can produce or reactivate typical patterns of attention, perception, action, communication, interpretation and emotion. These established types constitute resources for perceiving, knowing, acting, being affected, being engaged, etc. Types are not determinable and isolable, finite and discrete. They are grouped together in constellations of types drawing more or less coherent domains of relevance. Types are related to each other by chains of aperceptive transfers, clusters of non-representational references, or ante-predicative classifications and pre-logical inferences (Cefaï, 1994). According to Schütz, the constitution of types or patterns of experience is conceivable without the mastery of a language, but the latter represents the medium par excellence for the stabilization and transmission of types or patterns of experience. Let us emphasize here that types, typicality and typification are not to be understood in a cognitivist perspective: it's not a matter of retrieving a typicality that's already there. It is neither a process of induction nor a process of deduction but of an aperceptive transfer of

sense¹ between the unfolding phenomenal configurations towards other phenomenal configurations encountered in the past. This apperceptive transfer simultaneously allows to experience the typicality of what is given there as known, and the operation of typifications of what is given to be known. Therefore, it is only by an abuse of language that we speak of categorization, ante-predicative classification, prelogical inference, or practical reasoning. Apperception is not reasoning. Types are not concepts of intellectual activity; their relations are not governed by formal logic. Only a cognitivist analysis accredits this illusion a posteriori. Let us also add that types (or schemes of experience) are inseparable from what Merleau-Ponty (1968) called a carnal adherence of the sentient and the flesh of the world. All this goes hand in hand with a particular view of (body) memory: “*not considered an inner archive from which one withdraws particular memories, but a dynamical disposition that involves the organism in interaction with its environment*” (Ramírez-Vizcaya & Froese, 2019, p. 3). A kind of memory which “*does not ‘presentify’ the past through explicit recollection, but rather reenacts it implicitly*” (Fuchs, 2017, p. 335).

An Enactive View of Transformational Learning

Maiese (2017) recently worked on a reconceptualization of transformational learning according to enactive assumptions. These proposals are extensively discussed by Stapleton (2021) in an effort to clarify the outline of an enactive education. Transformative learning centers upon dramatic transformations and shifts in perspective and is not simply a matter of gaining access to new knowledge. O’Sullivan et al. (2002) sums this up perfectly by saying: “*Transformative learning involves experiencing a deep, structural shift in the basic premises of thought, feelings, and actions*” and describes it as “*a shift of consciousness that dramatically and irreversibly alters our way of being in the world*” (p. 18). This qualitative transformation of the structural coupling and of the perspective is sometimes associated with the notion of development. Maiese (2017) considers that Mezirow’s understanding of transformational learning is too dependent on metacognition. Calling upon enaction, her aim is to offer a different and more productive way to conceptualize transformative learning. For Maiese (2017), the enactivist approach emphasizes that the learning process is embodied, but also fundamentally affective. Therefore, she proposes to understand transformational learning in terms of affective reframing (and without relying on metacognition). This new openness and attunement to certain features of our surroundings involve a shift that is simultaneously both cognitive and affective. Transformational learning is thus understood as a pronounced alteration in cognitive – affective orientation, called affective reframing. The person who has experienced affective reframing lives in a different *umwelt* (von Uexküll, 1992) and considers (parts) of its environment with new eyes: “*They may be attuned to different parts of the world than they were before, and those parts they remain attuned to may be perceived differently*” and their meaningful experience from now on will “*be different as they will be*

¹ This apperceptive transfer occurs through the re-enactment of sedimented experiences, via passive syntheses of congruence.

structured through this different affective frame” (Stapleton, 2021, pp. 901–902). In other words, they become receptive and sensitive to previously unattended or untapped micro-perturbations in the environment, in part because some elements that previously had remained meaningless from within (out of their *umwelt*) now become meaningful. In other words, their own world change: the environment changes for them to include previously unattended or untapped micro-perturbation, but also the field of possible grips on it (Shvarts & Abrahamson, 2023). The transformation can happen subtly, and over time at a more or less pre-reflective level. Maiese’s transformative learning theory also expands the notion of habits of mind (present in Mezirow transformative learning theory) by including bodily and affective habits.

Maiese’s theory of affective reframing is considered an important development by Stapleton (2021), who nevertheless notes that “*it might not yet fully characterize the target phenomenon of transformative learning theory, i.e., the state that the transformation of habits of mind is supposed to bring about: perspective enlargening*” (p. 902). Stapleton (2021) concedes that Maiese’s understanding seems too permissive because it does not adequately distinguish between perspective shifting and perspective enlargening. For her, not all perspective shifts that result from transformed habits of mind are equally valuable with respect to developing an enlarged perspective. Maiese’s theory of affective framing therefore, despite its obvious interest, does not yet fully provide a way to differentiate between all the kinds of perspective changes and the perspective enlargening that is the target phenomenon of transformational learning theory. In this sense, it is an instance of a subset of perspective shifts in that it is, of course, a shift in perspective, but not just any shift: it is a shift in a positive direction. Stapleton (2021) concludes by also discussing the term “enlargement” itself (used in Mezirow theory). She proposes, within an enactive education, to re-characterize the target phenomenon of transformational learning theory from “enlarging perspectives” to “deepening perspectives”.

Based on the ideas put forward above, we consider that different forms of learning can be targeted during training: (i) perspective-refining (about elaborating or reinforcing existing types and relations between types), (ii) perspective-taking (about creating new types or relations between types, potentially accompanied by a weakening of existing types or relations between types), and/or (iii) perspective-shifting and perspective-deepening (about cosmological revolution of existing types or relations between types, *Umwelt* dramatic shift, change in receptiveness and sensitivity, and transformation of bodily and affective habits of mind).

Training Through Indirect Actions, Perturbation, and Promoted Actions

What should trainers do? Our position is that training activity aims primarily at a transformation of the trainees’ activity. Under the enaction assumptions, however, this is considered a paradox: How can we claim to influence and support the transformation of the activity of others, when it is thought to be autonomous (Varela, 1981)? Trainers are faced with the conceptual and practical difficulty of transforming others’ autonomous activity. Therefore, they can only act indirectly by producing

a transformation of the trainees' environment and hoping that it will be relevant for them (i.e., “bursting” in their own world). Under this condition, they might be able to trigger transformations of the activity and individuation (Simondon, 2005). The trainer becomes a designer of “perturbations” of the actor–environment coupling (during training) through indirect actions and supports as much as possible the process of appropriation–individuation. Let us take the example of an instruction. The difficulty lies in the fact that prescriptive instructions do not determine or command the activity of others. An external instruction is not “a form-giving operation”, since it is the activity that is a “taking-form process” that is carried out by appropriating the instruction if the latter constitutes a relevant anchoring for the actors. The concretization of these presuppositions leads to a correspondence between two types of transformations: those of the trainees' environment under the effect of the trainers' actions, and those of the coupling of the trainees and their situation. If the match is sought between these two transformations, it remains unpredictable, in the sense that what effectively initiates the transformations of the trainees' activity consists of an intervention on their environment, which is a gamble on the future.

Table 1 synthesizes the trainers' modalities of action according to the enactive approach: (i) indirect and negative action, (ii) perturbation and dosage, and (iii) design of fields of promoted actions, simulations, interactions, and consensually coordinated actions.

Design Principles for Vocational Education and Training

Being design-based, our approach is concerned with the production of knowledge related to design and the identification of relevant design principles. The focus on the evolution of design principles differentiates DBR from much action research and formative evaluation designs: “*The design is conceived not just to meet local needs, but to advance a theoretical agenda, to uncover, explore, and confirm theoretical relationships*” (Barab & Squire, 2004, p. 5). This section provides an overview of design principles that are both a token and the results of our DBR studies. We articulate two broad principles for training design and five enactivist inspired design principles. These design principles are based on both our theoretical assumptions (enaction and experience) and empirical results.

Two Broad Principles for Training Design

Design Training Environment with Activity at the Core of Everything We Do

We consider that: (i) the understanding of the messiness of real-world practices is crucial in vocational and continuing education and training to bringing authentic working practices to the curriculum, defining practice-based objects of learning, improving pedagogic practices, and designing efficient learning environments; (ii) the distinctions between what needs to be done (tasks or prescribed work) and what workers really do (real work), or between work-as-imagined (functional work

Table 1 Trainer Modalities of Action According to the Enactive Approach

	Description
Indirect and negative action	<p>Training through indirect action Trainer cannot directly teach anyone anything or transform his or her activity; at best, you can create, modify, enrich or design its environment “with the expectation of an indirect transformation of the actor – environment coupling (accepting the undecidability of learning, transformation and training). The trainer’s action is therefore always indirect. It must be thought of as a transformation carried out with care of the environment. This can mean playing with (or transform) the constraints of the environment (according to a constraint-led approach), amplifying certain environmental anchors, or enriching the environment with artifacts. In short, training is an intervention aimed at transforming the environment, with a wager on the future in terms of transforming the trainees’ activity.</p> <p>Training through negative action Negative action does not mean inaction or discouragement. It means giving primacy to proscription in the way training environments are designed, rather than prescription. The so-called positive action involves imposing a unique pathway according to a predefined scheme, while the so-called negative action closes certain pathways, evaluating the outcome only retrospectively. Ironically, when a trainer prescribes a series of steps for someone else to follow (the trainee), he is proscribing an unknown set of alternatives (with no opportunities to explore these alternatives). When the designer sets constraints through proscription, he or she is providing guidance, but not determining a unique way of doing. Proscription does not define a correct route making the exploration of new alternatives possible (everything that is not forbidden is permitted). Trainees in such an environment would be constantly challenged to be creative. It seems more interesting and fruitful to rely on an explicit proscriptive approach rather than on a blinding prescription approach that allows “unthinking” proscriptions to operate behind-the-scenes. The notion of negative action is also a switch from a « form – receiving» ontology (very active in the training field) to an ontology that gives primacy to « form-taking activity», in other words, it is a break with a hylomorphic model.</p>

Table 1 (continued)

	Description
<p>Perturbation and dosage</p>	<p>The ecological dynamics approach and non-linear pedagogy (Button et al., 2021; Chow et al., 2007; Davids et al., 2008) offer promising avenues for putting this principle into practice in vocational and continuing education and training. This is also the position of Abrahamson and Sánchez-García (2016) in school context.</p> <p>Training through perturbation</p> <p>This principle is the core of perturbation training approach (Gorman et al., 2010). A perturbation is defined as an extrinsic application of force that briefly disrupts a dynamic process, forcing the reacquisition of a new stable trajectory. Gorman et al. (2010) applied this dynamical concept of perturbation to team training by disrupting standard coordination procedures multiple times during task acquisition, forcing teams to coordinate in novel ways to achieve their objective. This approach is extended in our studies to all forms of training. Perturbation is the way to transform trainees' activity by introducing external disturbances that force them to find new solutions or new ways of doing. Trainees are constrained to enact new cognitive structures in/through structural coupling.</p> <p>Training through dosage</p> <p>The role of the trainer is to exploit the metastability of the structural actor – environment coupling and to adjust the dosing of the perturbation according to training objectives. This means “to make way for” shock or an event (leading, for example, to a temporary incapacity) aimed at disrupting the structural actor – environment coupling, producing an instability and a reconfiguration of the coupling. The notion of non-proportionality, which is a hallmark of nonlinear system behavior, must be kept in mind here.</p>
<p>Design a “field of promoted actions, simulations, interactions, and consensually coordinated actions.”</p>	<p>This principle is derived from the concept of <i>fields of promoted action</i> (Reed & Bril, 1996), its revision (Durand, 2008; Récopé, 2001), and its extension here to include simulations, interactions, and consensually coordinated actions. We assume that trainer action must foremost be thought of as the design of “fields of promoted actions, simulations, interactions, and consensually coordinated actions”, that, it is hoped, will be propitious for learning and transformation. The designed <i>fields</i> are promising precursors that encourage actions, simulations, interactions, and coordination that foster opportunities for knowledge or transformation “to be enacted” in the actor-environment</p>

Table 1 (continued)

	Description
	<p>coupling. However, we should point out that they are not the field of relevant actions, simulations, interactions, and consensually coordinated actions of the actor (Rietveld et al., 2018). This principle assumes that any learning or transformation is rooted in a whole bodily (including intercorporeality and flesh of the world), sensorimotor, affective, interactive, and experiential engagement. Later, Abrahamson and Trninic (2015) also proposed to give a central place to the notion of fields of promoted action in their embodied DBR approach in school context.</p>

process description) and work-as-done is a crucial issue to address; and (iii) the concept of activity (and its enactive inflection) is fruitful to understand the real work practices in a holistic and dialectic way (e.g., Filliettaz et al., 2015).

The empirical analysis of activity is crucial prior to and during every design process. Prior to the design process, activity analysis enables researchers/designers to capture professional embodied and lived experience in work situations and to design training environments that accurately address work-as-done (i.e., what people actually do). It is a critical driver for designing training contents and activities “that matter”. The training contents are defined through the analysis of the activity giving rise to lived experience and not only based on the “insider” knowledge of trainers (who are often experienced ex-workers). In addition, training activities are revamped with the objective of “putting to work” activity giving rise to lived experience during training sessions. During the design process, and especially the DBR design process, activity analysis is useful for the study-design-enact-study iterative process and enables the designer to capture the trainers’ and trainees’ embodied and lived experience (and learning) in the training environment being designed.

Table 2 summarizes how activity is at the core of everything we do in terms of training design and the consequences of the enactive inflection given in the definition of this concept.

Design Training Environment that Supports the Instauration of New Attentional Anchors and Distinctions

The transformation of attentional anchors (Hutto et al., 2015) and the instauration of new distinctions (Maturana & Varela, 1987) are targeted during training, insofar as they constitute preludes or prodromes to any other transformation or conceptualization (knowledge, concepts, and reflection). Both play a crucial role in the developmental passage from embodied interaction to content knowledge.

Attentional anchors come to the surface in our consciousness as our “felt way of doing things”. They become the things we refer to as we reflect about and explain how we are doing what we are doing. Attentional anchors emerge *ex nihilo* into the

dynamics of an agent–environment task-oriented interacting system. But at the same time, an attentional anchor is the focus of an actor’s interaction with the environment that is brought forth as the agent’s skill set that grows through engaging in a task. Hutto et al. (2015) argue that “*attentional anchors constitute the missing link between action and concept*” (p. 384) and consider that “*what we call learning is developed responsiveness to attentional anchors in the ‘field of promoted action’*” (p. 378).

Distinctions are core elements of Maturana and Varela’s works. They are considered as the basic operation that an actor or an observer performs in the praxis of living. Distinction is the basic act of splitting the world into what we consider separable and significant entities; in other words, splitting the world into parts of “this and that”, “us and them” or “environment and system” (Varela, 1979). Through distinction, an actor, an observer or a system draws a boundary around something (which does not necessarily have to be present at the time), brings it forth by cleaving it from the background out of which it came, and specifies a unit as a distinct entity from a background and a background as the domain in which an entity is distinguished. Distinctions fundamentally cleave a continuum and break the transparent flow of experience. The actor or the observer become able to distinguish something. This “something” could be characterized by its vagueness but may also be an emerging coordination of coordinations giving rise to languaging. The aim of training could be to support the emergence of new distinctions in the flow of experience and to encourage their recursiveness (when distinctions serve as the basis for the distinctions that follow).

Five Enactivist Inspired Principles for Training Design

Table 3 presents five enactivist inspired design principles derived from / and empirically documented in our DBR studies. These principles are presented below in dialogue with studies that have been subsequently published in the literature. These later studies not only confirm these principles but also have led to their renaming and refinement.

Principle 1. Encouraging As-If-fing and Mimetic Experience

Mimetic experience consists of living an experience resembling another but without being reducible to it. This two-sided perspective is a fusion or synthesis that can be figured as a double negation “not, but not not” (Willerslev, 2004). This experience is associated with a dual engagement with the situation. It supposes a discrepancy, circulation and overlap between the engagement “in the actual situation” and the engagement “in the played, imagined, or envisioned situation”. Actors enact meaning in and through their actual environment but related to another situation (Horcik et al., 2014). Mimetic experience involves a kind of play-acting or pretense that distinguishes it from a direct, serious, utilitarian and unequivocal engagement. But the players are never really becoming the roles they are playing. For example, trainees during the simulation never forget that they are in the simulation and not in real life,

Table 2 Core ideas of an Activity-Centered and Enactive-Oriented Training Approach

	Specified in terms of activity	Specified in enactive terms
1.	<p>Training content must be indexed to real work practices and work-as-done. Training activities must "put to work" real work practices and work-as-done during training sessions.</p> <p>Training aim is to initiate transformation of real work practices (and not to acquire prior knowledge).</p>	<p>...as the outflow of actor – environment coupling (including others and materiality);</p> <p>...as a whole bodily, affective, cultural, material and experiential engagement;</p> <p>...as it gives rise to lived experience (or pre-reflective self-consciousness).</p>
2.	<p>Training aim is to initiate transformation of real work practices (and not to acquire prior knowledge).</p>	<p>...as a whole bodily, affective, cultural, material, and experiential engagement;</p> <p>...as a continuous sense-making instauration;</p> <p>...including symbolic and preliterate—or non-symbolic—aspects);</p> <p>...through perspective-refining, perspective-taking and/or perspective-shifting and perspective-deepening.</p>
3.	<p>Training is itself a real work practice.</p>	<p>Training is itself an activity...</p> <p>...as a third-order coupling between two or more actors;</p> <p>...as an inter-enaction (including materiality);</p> <p>...involving the entire spectrum of participatory sense-making (from orientational to joint sense-making);</p> <p>...involving (recursive) consensual coordinations of actions</p>

even as they live out a mimetic experience. Mimetic experience implies engaging in the training environment in a way that is at the same time both fully committed to it, and thus serious about it, and fully aware that one is play-acting. With regard to training, the aim could be to provide opportunities or possibilities for mimetic engagement and to design a training environment that supports as-iffing (Stapleton, 2021) and imagination. Sometimes, imagination not only does not prevent us from reaching real life, but is an indispensable condition for reaching it.

Principle 2. Supporting the Enactment of Metaphors (or Enactive Metaphors)

Metaphor refers to “*understanding and experiencing one thing in terms of another*” (Lakoff & Johnson, 1999, p.5). An efficient metaphor will lead us somewhere, open up an insight, show us something that we could not see before. It establishes a new resemblance (created ex-novo) through a previously absent relation. Metaphors are a path of appropriation and creation of the unprecedented, starting from previous meaning. Thanks to metaphors, it becomes possible to feel or approximate something, to apprehend the unknown, to anticipate future actions, and to move later toward conceptualization and abstraction. Metaphor may play a significant role in structuring one’s experience, and consequently in perspective-shifting and perspective-deepening (Salini & Poizat, 2021; Salini & Durand, 2012, 2020). It gives a new meaning to the present and also guides (without determining it) the future in a new way: future action adjusts to the metaphor, which in turn makes the experience coherent. As indicated by Lakoff and Johnson (1999): “*The metaphor is, in most cases, used for reasoning, it may impose a nonliteral ontology that is crucial to this reasoning, and there may be no nonmetaphorical conceptualization that is adequate for reasoning with the concept*” (p. 72–73). A metaphor is often something “awaiting conceptualization” (a not yet conceptualized content) – something that is at the same time deeply known and eminently new. Several particularly interesting studies attempt to embrace a radical dynamical–ecological approach to metaphor and to reexamine its function (Abrahamson, 2020; Abrahamson et al., 2016; Gibbs, 2019). In this context, it is assumed that metaphor is not a discrete event or activity that is suddenly “there” inside the head “*but is a dynamical constraint on action that is distributed across brains, bodies, and real-world ecologies*” (Gibbs, 2019, p. 35). Metaphorical instantiations are embodied, enactive, embedded, and extended. Based on the empirical analysis of instructional metaphors (Abrahamson et al., 2016), Abrahamson (2020) proposes that metaphors be understood as projected constraints on action–perception dynamics. As such, metaphor is retheorized “*as a sensorial constraint one imaginarily projects into one’s action–perception phenomenological landscape*” (p. 216). With regard to training, the aim could be to design a training environment giving opportunities for (i) the combination of primary metaphors into large complex metaphors (primary metaphors are fully embodied: they are embodied through bodily experience in the world, which pairs sensorimotor experience with subjective experience); (ii) a conflation stage (Lakoff & Johnson, 1999), during which connections between coactive domains are established and the domains are not experienced as separate; (iii) a differentiation stage, during which domains

Table 3 Enactivist Inspired Design Principles for Training Design

Design principles	Apophthegm	Specific studies from our own research program supporting each enactivist inspired design principle
Encouraging as-iffing and mimetic experience	<i>"Not but not not"</i>	The transformative potential of mimetic experience was empirically documented during simulation and video-based training. (Horcik et al., 2014; Leblanc, 2014; Leblanc et al., 2021)
Supporting the enactment of metaphors (or enactive metaphors)	<i>"Seeing something as something else"</i> <i>"Knowing the unknown"</i>	The transformative potential of metaphors was empirically documented during theatrical practices or filmmaking practices for educational purposes and adult counseling practices. (Salimi & Poizat, 2021; Salimi & Durand, 2012, 2020)
Promoting ritualized "as-iffing-the-other"	<i>"Oneself as another, and the other as oneself"</i>	The transformative potential of ritualized "as-iffing-the-other" was empirically documented during video-based training. (Leblanc, 2014; Leblanc & Seve, 2012)
Promoting re-enactment	<i>"Re-presenting the past"</i>	The transformative potential of re-enactment was empirically documented during VR-based training or theatrical practices for educational purposes. (Drakos et al., 2021; Salimi & Durand, 2020)
Nudging participants into new affective frames	<i>"In the beginning were the affective frames"</i>	The transformative potential of nudging into a new affective frame was empirically documented during simulation and video-based training. (de Bisschop et al., 2022; Flandin et al., 2018; Schot et al., 2019)

that were previously coactive are differentiated into metaphorical sources and targets; and (iv) metaphorical pluralism, given that metaphor can be private and individual, or potentially consensual and cultural. But above all, training must promote an enactive engagement with a metaphor in a fully embodied way rather than a passive encounter with sitting metaphors (Gallagher & Lindgren, 2015). As Jensen and Greve (2019) state “*metaphor is to be seen as neither a figure of speech nor a figure of thought. Rather, metaphor is a figure of action. It is a doing that is embedded in the ways that we do things in the world, and as such it can be understood as skillful manipulations of environments of any kind*” (p. 2).

Principle 3. Promoting Ritualized “As-Iffing-the-Other”

Ritualized “as-iffing-the-other” (Stapleton, 2021) entails “mimetic experience with others”, with simultaneous feelings of likeness and difference. Experience consists in living one’s own experience as “other” through expropriation and in living the “other” experience as its own thought appropriation. “Others’ as-if-ness” completes the “as-if world” of mimetic experience, and vice versa. As-iffing-the-other can be done in different ways: (i) by the appropriation of the emotions-intentions inferred or identified in the other, (ii) by living the other situation from its own emotions-significations-intentions, or (iii) by appropriation-transformation of the situation through a process of anticipation-projection of different actions-intentions. Merleau-Ponty’s notion of intercorporeality and its revisit (Tanaka, 2014, 2015) as a reciprocal perception–action loop between the self and the other shed light on these phenomena. Perceiving the other’s action prompts the same action in the self or its possibility, and vice versa. For Tanaka (2014), it is the process underlying the understanding of intentions in another’s actions.² It is particularly interesting to ritualize interpersonal interactions and “as-iffing-the-other” (Stapleton, 2021). As pointed out by Stapleton (2021), in an “as-iffing-the-other” ritual space, nobody tells anyone how to behave in the real world. This works because each participant plays a role other than the one he or she normally inhabits. Rather, it seems to be the activity itself of engaging in the play that – indirectly – enables the participants to become disentranced from their perspectives and provides the opportunity for perspective-taking or perspective-shifting and perspective-deepening. With regard to training, the aim could be to design a training environment giving opportunities for “as-iffing-the-other” (for example, video-based training) and ritualizing/encouraging interactions between actors around “as-iffing-the-other”. The aim is thus to encourage participatory sense-making, consensually coordinated action, appropriation of others’ lived experience, expropriation of one’s own lived experience, and mutual appropriation.

Principle 4. Promoting Re-Enactment

Re-enacting some aspects of the past involves re-presenting the past. It is a recommitment of past experience in a living present reality, which is neither mere

² “Perceiving the other’s action, we immediately grasp the intention through our motor capacity and react in response to that intention” (Tanaka, 2014, p. 271).

recollection, nor narrative, nor even reliving the past situation. The actor's experience is not merely that of reactivating a past experience or rethinking a past thought, nor of performing a thinking-act that is identical or similar to the first. Re-enactment is about performing the past for present purposes and connecting that past with the present through imagination, constantly "*quoting from the past, but erasing the exact traces in order to gain full meaning in the present*" (Rokem, 2000, p. xiii). The re-enacted past upholds a complex temporality: it is not entirely present or completely constructed in the here and now, but neither does it, obviously, allow access to an unmediated past. It is the past that is present here and now. The engagement appears inherently bilateral, occupied by the past and the present. The potential of re-enactment for training/learning was pointed out in some of our studies (e.g., Drakos et al., 2021) but also more broadly (e.g., González-González et al., 2022). There are various re-enactment practices: theatre re-enactment, performance art re-enactment, filmic re-enactment, VR re-enactment, and what is often referred to as "living history". With regard to training, the aim could be to design a training environment giving opportunities for re-enactment and benefitting from these existing practices. Various factors seem decisive to re-enact the past through, with and in the actors' bodies: participation, performance and play.

Principle 5. Nudging Participants Into New Affective Frames

Nudging participants into new affective frames emphasizes that (i) the learning process is embodied, but also fundamentally affective; (ii) pedagogy that engages the body and emotions is important; and (iii) affective reframing precedes conceptual reframing (Maiese, 2017). The question here is to take into consideration the integral role that affectivity plays in transforming an actor's overall mode of being, including their characteristic ways of attending to, interpreting, and engaging with the surroundings. An actor's new "openness" and attunement to certain features of their surroundings involves a shift that is simultaneously both cognitive and affective (Maiese, 2017). With regard to training, the aim could be to design a training environment giving opportunities for a pronounced alteration in cognitive – affective orientation. The trainer could take advantage of the material scaffoldings of affectivity and use material property to "affect" trainees (Colombetti & Krueger, 2015). But trainers could also design challenging, demanding or threatening training environments with consequences in terms of "physiological arousal" and "experienced arousal".

Conclusion

The purpose our paper was to introduce a DBR approach based on a pragmatic and phenomenologically inspired enactivist approach to activity. Previous studies have confirmed that DBR can lead to conceptual, theoretical, and practical developments in the field of vocational and continuing education and training (e.g., Leeman & Wardekker, 2011) by (i) exploring possibilities for creating novel learning, vocational, and continuing training environments; (ii) developing theories of learning,

training and professional development that are contextually based; and (iii) advancing and consolidating design knowledge. For their part, our own studies contribute to the current knowledge of design by providing broad design principles for vocational education and training and specific enactivist inspired principles for training design. They also contribute to the theories of learning by providing, for example, a new understanding of mimetic learning (e.g., Billett, 2014). Moreover, our studies produce demonstrable changes at the local level, which is evidence for the viability of our activity-centered and enactive DBR approach. As Barab and Squire (2004) stated, DBR studies have to demonstrate the value of the design in terms of the impact on learning in the local context, and they cannot limit themselves to theoretical or methodological advances. Needless to say, our article does not give a full picture of activity-centered and enactive DBR in vocational and continuing education and training. This would require not only addressing the “doing” of activity-centered and enactive DBR (steering group, roles of practitioners, iterative process of study-design-enact-study, modeling and boundary objects, co-design, ethical issues...), but also the conceptualization of design activities like participatory sense-making. It should also be noted that further work is needed to study successes and failures. It is essential to carefully examine and publish the findings about projects and partnerships that prove unsuccessful and to study how successful projects fade and degrade over time. Understanding how successful designs both survive (with tailoring, appropriation, and translation) and break down must be a main purpose and implies long-term partnerships. Cole and Packer (2016) proposed to study successful innovations until they fail. Every innovation has a life cycle (in time, everything fails) and longer time scales are important to understanding what needs to be done in design.

It has been argued by others that the enactive approach opens promising pathways in the way we comprehend cognition and learning (e.g., Fenwick, 2000). The additional step here is to ground DBR in enactive assumptions and to formalize enactivist inspired design principles for vocational and continuing education and training. The current effort to synthesize enactivist inspired design principles is complementary to that proposed by Abrahamson et al., (2020, 2022) concerning enactivist pedagogy design and facilitation. These authors listed several design principles that have emerged from their (design-based) research program on classroom practice. Further work is needed not only to determine the effectiveness of each enactivist inspired principle for training design, but also to complete this non-exhaustive list. Let us mention as an illustration the possible principle “promoting storytelling and narrativity” (Popova, 2015). The transformative potential of storytelling and narrativity was pointed out not only in the study on the design of VR-based training situations for nuclear power plant operators (Drakos et al., 2021), but also during theatrical practices or filmmaking practices for educational purposes (e.g., Durand et al., 2020 ; Salini & Durand, 2020). Another possible principle is “supporting recursive consensual coordinations of actions” (consensual coordination of consensual coordinations of actions) (Maturana, 2000). The transformative potential of recursive consensual coordinations of actions was recently empirically documented during debriefing and video-based training (Dieumegard et al., 2022). Obviously, multiple other enactivist inspired works in the field of learning sciences (without necessarily

employing the concept of activity) could advantageously complement and enrich these principles (e.g., Abrahamson et al., 2011; Aden & Eschenauer, 2020; Coles, 2015; Lingren et al., 2016; Maheux & Proulx, 2015; Maiese, 2013; van der Schyff et al., 2016), as well as research in other fields like sport sciences (e.g., Ganachaud et al., 2023; Rochat et al., 2020).

Finally, a last point will be of interest to researchers/practitioners in vocational and continuing education and training. Most of the enactivist inspired design principles suggested as a result of our studies are also promising pathways to enhance the connectivity between work experiences, between authentic work practices and training, and between learning contexts. Longstanding themes in research on vocational and continuing education and training have been focused on: (i) how to bring school learning closer to real life situations and practices; (ii) how to facilitate learning through work even without practicums or work placements; (iii) how to facilitate the integration of conceptual knowledge and practical knowledge, which is fundamental for the development of expertise; and (iv) how to integrate work-based or practice-based experiences into learning in vocational and continuing education programs. Some of the principles mentioned may be a part of the solution or a way to deal with these themes during design. Moreover, considering activity as the keystone of the DBR approach, as we suggest, is a guarantee for the design of training contents and environments “that matter”. In continuing and professional education, it is fundamental that design addresses “first-person relevant” and “practices relevant” training content, close to real work practices and experience, with the prospect of a didactics of work practices (Billett, 2011). The focus on activity and the enactivist inspired design principles provide tools for ordering, enacting, experiencing, and taking full advantage of practice-based experiences during training.

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Declarations

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