

# Learning and Shaping Expert Knowledges: The Case of Precision Medicine

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## Abstract

The aim of this article — drawing on broad ethnographic research within two major Italian organisations operating in cancer care and research — is to enlarge practice-based studies, and in particular the practice-based approach to learning. To do so, a dialogue with social studies of biomedical science and health professions will be open, thus contributing to the field of sociology of scientific practice, which often neglected to explore how practitioners locate themselves in a position to be able to act as competent agents. Accordingly, we shall ask: what kind of knowledge is enacted to create a context of work in which “precision medicine” emerges? Since research and care practices as collective activities are not merely predefined by formal education and training, how practitioners learn to work together, and to shape knowledge actionable within a precision medicine frame? In addressing these research questions, the article shows how a practice-based approach to learning might offers novel modes of understanding biomedicine and to think somewhat differently about how expert knowledges are produced and shared among diverse settings and professionals.

**Keywords:** Practice Theory; Biomedicine; Healthcare Professions; Learning in Practice; Ethnography.

## 1 Introductory Remarks

A science is nothing more than, and nothing less than, the activities of its practitioners.  
(Garfinkel & Liberman, 2007, p. 4).

The aim of this article is to enlarge practice-based studies, and in particular the practice-based approach to learning. To do so, a dialogue with social studies of post-genomic biomedicine and health professions will be open, thus contributing to the field of sociology of scientific practice which often neglected to study how practitioners locate themselves in a position to be able to act as competent agents (Alkemeyer & Buschmann, 2016).

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For the scope of this paper, it is worth highlighting that a growing body of research inspired by a practice-based approach to learning is revolving its attention to mundane activities (Alkemeyer & Buschmann, 2016). However, they rarely explore upon how scientific practices take place in the flow of practitioners' experience, where learning and knowing are not separate activities, but rather co-present with innovation, negotiation and conflict over specific purposes to be pursued in work practices. Thus, this study attempts to developing a novel modes of understanding biomedicine and thinking somewhat differently about how expert knowledges<sup>1</sup> are produced, learned and shared among diverse settings and professionals. In particular, the generation of biomedical knowledges will be framed as *act of knowing* and *learning in practices* (Gherardi, 2009), emerging via the entanglement of discourses, artefact, tools and biological entities. This perspective is particularly useful in enabling the understanding of such peculiar trajectories in becoming a competent member in a culture of biomedical practices.

The focus on learning in biomedicine allows for disclosure of situated practices in manufacturing expert knowledges as a practical performance, avoiding the reduction of learning process to a mere rational/cognitive act of mastering propositional knowledges. Indeed, within social sciences, scholars have traditionally approached the study of professions involved within the Western medical science and healthcare industry by postulating an empirical binarism: on the one hand, there are those engaged in producing expert knowledges as well as in developing medical technologies (i.e. professionals located in scientific laboratories); on the other hand, physicians and nurses who adopt these knowledges and technologies interacting with patients in the field of public health services (see Burri & Dumit, 2007; Gardner, 2017). This position outlines an analytical boundary between clinical practitioners and the research staff carrying out laboratory-based investigations in life sciences. Hence, it is assume that these communities have irreducibly different epistemological, cultural and value orientations (Hallowell et al., 2009; Morgan et al., 2011).

The foundation of this binarism resides in the hypothesis according to which medical professionalisation should be understood primarily in relation to the processes of development of the institutional health welfare systems, in their regional, cultural and biopolitical dimensions (Freidson, 1985; Abbott, 1988; Erling & Magnussen, 2011). However, this hypothesis is losing its centrality in social sciences, as well as its heuristic power, due to the radical technoscientific reconfiguration to which biomedicine has been subject in the last two decades (Clarke et al., 2010). Recent innovations in healthcare, such as DNA sequencing and genomics, are leading to a critical transformation of biomedical organisations, clinical practices and healthcare professions (Keating & Cambrosio, 2003). Among many different medical specialities, oncology has been particularly affected by genomic technologies, driving the emergence of precision medicine (also known as "personalised" medicine), which opens new clinical options for treating patients as it combines traditional drug administration evaluation factors (e.g. age, body mass index and gender) with the patient's unique genetic, environmental and behavioural profile (Ginsberg & Willard, 2013). In this respect, a growing body of research shows that post-genomic sciences are realigning the "clinical" (Foucault, 1973) and "molecular" gaze (Rose, 2007) over the human body, strengthening relationships between research laboratories and care practices (Lewis et al., 2014; Nelson et al., 2014; Cambrosio et al., 2018).

In consideration of this complex biomedical landscape, the challenge for social sciences is no longer to question ethical issues related to the possibility of manipulating and intervening at the molecular level of the living bodies. Rather, it is to explore the organisational arrangements and situated conditions surrounding the development of new tailored therapies in the context of technology-intensive biomedicine. Accordingly, we shall ask: what kind of knowledges are enacted to create a context of work in which "precision medicine" emerges? Since research and care practices as collective activities are not merely predefined by formal education and training, how practitioners learn to work together, and to shape knowledges actionable within a precision medicine frame? To provide a meaningful answer to these research questions the article is organised as follow: first, I provide a comprehensive theoretical framework that informs this paper. Then, I detail the research design, and I present the empirical material using case vignettes to illustrate how health practitioners learn to collectively act in a competent way within a thick network of relationships involving clinical settings and research laboratories. In the con-

1. I resort to the plural "knowledges" to emphasise that scientific knowledges are heterogeneous assemblages, and may be disputed, repudiated and locally negotiated. See Haraway, 1991; Clarke et al., 2003; Jasanoff, 2004.

clusion, I consider the type of research insights that the conceptual work of a practice-based approach to learning might open up in the case of contemporary biomedicine. In so doing, I discuss how the developing of expert knowledges and new medical options can re-orient the work and settings of those concerned in health settings, and how their doing implies collective expert competences that must be learnt and innovated while practising.

## 2 Working and Learning in Biomedical Landscapes

Although social sciences have historically developed multifaceted perspectives in addressing how innovations in policy frameworks, as well as advancements in science and technology, contribute to redefining the cultural authority of health professions, it is common to consider the medical sociologist Eliot Freidson as the foundational scholar of the research stream on medical professional bodies (see Hafferty & Castellani, 2013). One of the main influential legacies of Freidson's thought is the concept of "medical dominance" (1970). This notion has been proposed with the aim of highlighting the chance of the "medical category" to subjugate — by means of a legal authority, and cultural and symbolic resources — all the occupational profiles in the health domain, and to hegemonize the definition of the scientific contents of their activity. From this perspective, physicians have been able to develop monopolistic economic strategies in order to give shape to their own privileged labour market segments, thus increasing their benefits and their moral force, and subordinating competing occupational groups to their purposes (Collins, 1979). According to Freidson, the profession of medicine is played with a radical ambivalence: on the one hand, there are the social expectations that require caring for patients; on the other, the problem of building consensus and legitimacy both within their own professional community and in society at large. In this way, the exercise of the medical profession contemplates two distinct logics of action, that is the *colleague-dependent logic* and the *client-dependent* one (Halpern & Anspach, 1993).

Freidson's work has strongly pervaded social studies of healthcare professions, and, in particular, the well-known theory of medicalization (Conrad, 1992 & 2007). Although in principle this theoretical framework considers diverse viewpoints of professionals engaged in the medicine and healthcare field, the perspective of physicians remain the *primum movens*, thus suggesting a political tactic of domination acted by the medical category as an explanatory factor of the dynamics shaping the healthcare professions (Chamberlain, 2010).

This analysis has been questioned by social researchers involved in innovation studies, social studies of medicine and science and technology studies (S&TS), commonly interested in investigating the re-configuration of the epistemic and organisational boundaries between care and research, as well as the modalities through which biomedical work occurs in practice. Both in Europe and in North America, in debates over the production of (biomedical) knowledges and technologies of life, innovative "heuristic lenses" have been proposed to capture the mutual shaping and multidimensional entanglement between care and research (Cambrosio et al., 2018). These contributions have framed medical work as a form of "heterogeneous engineering" (Bruni, 2008), that is a distributed process, which implies forms of cooperation between various lay and expert practitioners as well as technological devices (Casper & Berg, 1995; Lock, Young & Cambrosio, 2000; Rabeharisoa & Bourret, 2009). Therefore, sociologists influenced by S&TS have strongly renewed the study of medical practice, thus overcoming individualised methodological approaches that framed social structures in terms of external variables determining the nature of the clinical acting.

Although these studies have produced extremely relevant advancements in understanding the ways in which genomic technologies and ICT are blurring the distinction between care and research professionals, the approach is partial in that health practitioners tend to be cut loose from the ways in which they learn to competently perform everyday working practices. Generally speaking, this scholarship has depicted biomedical work as highly standardised and conservative; innovation as a destabilizing, even if indispensable, process of organisational change; and learning as a peculiar dimension weakly related to everyday work and innovation. According to Brown & Duguid (1991, p. 40), "the source of the opposition perceived between working, learning and innovating lies primarily in the gulf between precepts and practices. Formal descriptions of work (e.g., 'office procedure') and of learning (e.g., 'subject matter') are abstracted from actual practice." Therefore, it is relevant to acquire a more thorough understanding

of how knowledges and medical technologies are produced in the course of everyday practices, and how practitioners learn to “perform” them as a part of everyday organising processes.

In addressing this issue, I discuss how precision medicine practitioners are engaged in learning to define knowledges about patients’ bodies in the context of precision cancer medicine. In so doing, I adopt a practice-based approach developed by Shove et al. (2012), which potentially allows seeing learning as a conceptual bridge between the process of innovating and working. In their consideration of practice theories, Shove et al. suggest focusing on *materials*, *competences* and *meanings* as a strategy to comprehend practices (2012, p. 14). A focus on materiality allows considering tangible physical things, biological bodies and technologies as integrative agents of practices. Competency encompasses techniques and skills, and the ways in which people learn them. Finally, meanings refer to expectations, aspirations and symbolic meanings. Accordingly, practices should be framed as the emerging outcome by the (in)stable assemblage between these three types of elements. In alignment with Shove et al. (2012), Alkemeyer & Buschmann (2017) recently proposed a heuristic framework to capture learning as a process of “self-(trans)formation” (p. 12) within practices, where “candidates for participation reciprocally initiate themselves as and make themselves into participants by equipping one another, with the collaboration of things, and artefacts, with situational possibilities of action and, at the same time, delimitating them” (*ibid*). This sensitivity is evidently grounded on the concept of “situated learning” (Lave & Wenger, 1991), which questions the reification of learning as an asymmetrical transfer of competencies from one person to another.

Moving from this constitutive tenet of practice theory, Alkemeyer & Buschmann (2017) conceptualise learning “as a process of participating in practices in which, alongside practical and propositional knowledges, identity and social membership are formed” (p. 12). Accordingly, I argue that healthcare professionals, including laboratory workers, are required to learn how to use technologies and how to competently locate themselves in a specific organisational context, the characteristics of which may co-define how drugs, medical protocols, or knowledges are produced and used (Shove et al., 2012). Thus, when I refer to the term “competency(ies)”, I do not have in mind the various formal norms and prescriptions in which “discrete,” and more or less related, tasks may be grounded; but rather the complex intertwinement of explicit and tacit knowledges, cultural and moral orientations, as well as taken-for-granted routines mobilized in bearing a concrete situations. In this perspective, the term competency acts in the manner of “sensitizing concept” (Blumer, 1954), allowing to understand knowing and learning-in-practice as source of innovation, making possible the same settings, conditions, rules and professional roles within which precision medicine is defined as such.

### 3 Methodological Note

Drawing on ethnographic research of running experiments to build care protocols for precision cancer medicine, the objective of this paper is to show how biomedicine can be analysed as “expert doing” and how, within it, a social researcher can empirically describe how *precision* is a process of situated *learning* and *knowing*. Ethnographic fieldwork was conducted in Italy at two biomedical organisations. The first is a major biomedical institute in northern Italy specialising in cancer care and research, primarily involved in managing genomic-driven clinical trials. The second, located in northeast Italy, is a research foundation, leading projects in cooperation with academic laboratories and hospitals with the objective of personalising treatment for cancer patients, especially those with leukaemia. Overall, observations were conducted at both organisations for six months. During this time, daily activities within research laboratories and hospital wards were followed. Handwritten field notes were taken during observation days, and 25 semi-structured interviews were conducted with laboratory researchers, molecular biologists, pharmacologists, chemists, data managers, clinicians, research nurses and medical laboratory scientific officers.

Given the paper’s focus, I have combined the pieces of data with the objective of tracing and following precision medicine practices across the different sites of knowledges production. In this respect, this paper originates from a series of activities synthesising findings and insights from different papers I have authored in this field (see Crabu, 2016, 2017, 2018). Hence, in the next sections, I analyse a series of “case vignettes” (Swan et al., 2007) focalised on precision cancer medicine in its “co-becoming”, together

with career biographies of practitioners (vignette 1 and 2) and organisational environments in which it is practised (vignette 1 and 3).

## 4 Findings

### 4.1 Vignette 1: Envisioning Precision

Generally speaking, precision cancer medicine refers to an ongoing biomedical endeavour aimed at boosting the translation of genetics knowledges to clinical routines. Medical discourse on precision medicine is usually dominated by a view of learning and training as a formal task of acquiring and possessing propositional knowledges, hence expressing a desire to render clinical actions more “rational” (Zuiderent-Jerak, 2015). But, if we orient the analysis on the day-to-day accomplishments of precision medicine, the monolithic agreement (which we easily notice in formal biomedical narratives) on the very meaning of being *precise* in caring for living bodies loses consistency:

I was walking down the aisle of the hospital ward in company of Mario, an oncologist at the dawn of his career, and Martino, a young Ph.D. student in the field of bio-nanotechnologies. The ward hosted both patients treated according to standard protocols and others enrolled in clinical trials. Today, drug infusions should be administered to patients enrolled in a Phase I, genomic-driven clinical trial focusing on single-nucleotide polymorphism (a DNA sequence variation) of the gene “UGT1A1”. This is an experimental protocol aimed at personalising treatments for patients suffering from colorectal cancer. While we were walking, Mario told us about his frustration with the way he is involved in this trial. “Nobody explained to me... maybe, I think, no clinician... ever told me the reason why the heterozygosity of the UGT1A1 gene can determine an altered metabolism of the drug, so that you can administer a different dose of CPT-II [i.e. Irinotecan, a drug used in the treatment of the metastatic colon or rectal cancer]. Just to be on the safe side, I went to read the protocol, but it was just out of personal curiosity. Sure, they [laboratory-based team] tell you: ‘have a look at the protocol yourself, study it.’ But this is not the point... The point is, that I feel the need to understand not the protocol, but how to get engaged in it... and sometimes, before speaking about translationality in medicine, we would need a little more coordination.” (Ethnographic fieldnotes on Mario, an oncologist involved in a department of clinical and experimental pharmacology - Human Ph@rma<sup>2</sup>)

Here, acting as a “precise” professional becomes a practical accomplishment, and precise “knowledges” are something that practitioners perform collectively by learning on how to manage a protocol as a matter of organising coordination arrangements. This happens by a processual reconfiguration of the concerned clinical setting, as a loci which can enable informal pedagogical trajectories. What is at stake, here, is to learn how to situate its own specific “piece of work” within a more large ecology of organizing interactions. In this respect, it is worth underlining that social science scholarship about the introduction of protocols for “precision medicine” in healthcare settings is deeply rooted in a conception of science as a *dispositif* of subjection (Dickenson, 2013; Prainsack, 2017), and as a proxy for deskilling of physicians. Accordingly, physicians — under the pressure of laboratory science — are supposed to be a mere executer of formalised Tayloristic tasks prescribed and crystallised in protocols, thus losing their alleged professional autonomy and “embodied skills” in caring for living bodies. A narration from the field can allow us to question this recurrent, even if highly disputable, reading over the reshaping of medical work:

[...] it seems more interesting, for someone like me who is very “clinical”, to follow patients within protocols managed by colleagues in the experimental unit, as I normally do in a Phase I protocol for personalising treatment for patients suffering from colorectal cancer. [...] So, you must follow the patient. You must assess whether that drug is good at that dose, that

2. Persons and locations names are pseudonyms



the “experimental people” think it is appropriate to administer for that mutation, for that particular genotype. By the way, it is the clinician who sometimes pays the bill [i.e. negative consequences]. Oh yes! Because maybe toxicity increases and, therefore, for you, there is a mountain of problems to face in the department. (Interview, Mario, an oncologist involved in the department of clinical and experimental pharmacology - Human Ph@rma)

To analytically capture this account, it is not sufficient to mobilize a “deskilling story”, since the protocols inevitably require to be contextualised within situated setting of actions. This process enacts a subjectivation process of the agents involved in translating scripts and the disposition of the protocols in practices (Akrich, 1992; Timmermans & Berg, 1997). Clinicians, as Mario’s account nicely shows, in “tinkering” the protocol, are deeply engaged in a process of learning new abilities in order to render such prescriptive text compatible both with the bodies of the patients (as non-docile agents) and with the local pre-existing and consolidated institutional, infrastructural and material relations.

Thus, what we observe is not a mechanical operation of adapting working routines to a new protocol. Accordingly, the protocol can no longer be considered as a device of linear deskilling and disempowerment of medical practices. On the contrary, practitioners in hospital wards engage themselves in a learning process as an affordance of the protocol in itself, required to manage conflicts between prescriptive texts and the complex yet unpredictable living bodies they work with. Indeed, by observing the “mise-en-contexte” (Latour, 1992, p. 89) of the protocol, we see how clinicians are not neutral followers of certain kinds of formal dispositions, but agents actively engaged in learning how to align their own perspectives, needs and professional skills with the protocol’s situated trajectory.

#### 4.2 Case Vignette 2: Dismantling Epistemic Boundaries, Reshaping Professional Biographies

The distinctive feature of current precision medicine relies on the application of genomics for producing clinically actionable knowledges. Genomic technologies, as the technical infrastructure of precision medicine, are not simply tools used in the production cycle of precision protocols, but rather are processes that must be developed in practices (Timmermans & Berg, 2003). These developments can have crucial consequences for the management of healthcare settings, as physicians, researchers and laboratory workers make increasing use of diverse expert knowledges that must be rendered mutually compatible and congruent among each other. Indeed, clinicians and life scientists may construct occupational cultures that are not professional *stricto sensu*; these cultures can collide with the traditional boundaries between care settings and research spaces as well as with the consolidated management of the interface between the normal and the pathological:

I started working in a university department of pharmaceutical sciences. I never, ever talked to an oncologist there. I have never been told: “Look, the drug must have certain characteristics because otherwise, it causes toxicity to the patient, or because my clinical problem is this and not another one.” It was a job weakly connected to the clinic, and on one hand, this makes you less conscious about the impact of your work. On the other hand, it gives you much more freedom to experiment with what you judge to be relevant for the science because you are not bound to the fact that tomorrow, you must apply what you did to a patient. Here, when I think about a protocol or a project, I always must think about the fact that the data I produce must be immediately, or in the immediate future, applicable to the patient. [...] So, on one hand, there is the possibility of growing professionally, and taking into consideration the applicability of what you are doing is certainly something that enriches you. At the same time, it is an aspect that limits the possibilities of exploring areas, or things that may be relevant for me, and which can also give you great satisfaction in terms of research, but from which you do not see the immediate effect anyway. For example, I characterise a protein, and the patient or clinician does not care about it, though it would be useful for other researchers [Michela, a pharmacologist involved in the Department of Clinical and Experimental Pharmacology - Human Ph@rma].

When Michela was hired by a research laboratory outside of the academic institution, her work changed profoundly, both from the perspective of the purpose and the technical means to achieve it.

This transition in her professional biography, shared by many other researchers involved in the organisations where I conducted the fieldwork, led to a broader redefinition of the meaning, modalities and materials of conducting everyday working practices, thereby requiring learning how to act within a novel “style of practice” (Keating & Cambrosio, 2012). The patient’s living body is recognised as the main driver in generating research hypotheses, around which both care and laboratory practices are articulated. Hence, it is a matter of constructing new technoscientific and organisational repertoires that can co-define the conditions for the actualisation of a “precision medical practice”, which professionals consider to be a good way to approach pathological conditions that may affect the body. Under this perspective, the object of knowing in practice in precision medicine will be knowing simultaneously how to work, co-produce precision protocols with colleagues and patients, and “perform” an occupational identity, since traditional professional identities (primarily shaped around a specific institutionalised discipline) are fading under the pressure of contemporary biomedicine as a complex multidisciplinary endeavour (Disis & Slattery, 2010). The act of knowing concerns a learning process of how to accomplish participation and inter-professional relations as the generative effect of common practice.

### 4.3 Case Vignette 3: Enacting Precision Knowledges

Although ambivalences at the interface between the laboratory personnel and the clinical staff emerged, these were considered part of the field:

In the late afternoon, Pina (a senior experimental pharmacologist) — while discussing with her main assistant over a day entirely spent within the hospital ward — reflects on the “down-to-earth” practices required to correctly implement a protocol: “Have you ever noticed how important is to follow the nurses to make sure the blood samplings are done correctly? As I told you, it was a great achievement to engage dedicated research nurses in our clinical trials. They better understand how important is even just a minute to pharmacokinetics. If it is expected that the infusion run for 2 hours, but then it runs just for one hour and a half, because there is a problem with the infusion pump, like today... or maybe they notice that they are infusing a wrong dose of the drug, and therefore the infusion is stopped sooner... I need to be aware of all these events, because they are an extremely important source of information for conducting the pharmacokinetics [the study of the drug metabolism] in a proper way. Then, in the evening, of course, research nurses are replaced by general nurses. [...] But I’m trying to give make them aware of the importance of strictly respecting the schedule of the blood sampling or, at least, in case of error, to report it on the register [a form that records the blood sampling procedures]. This is why I guess our presence in the hospital ward is fundamental. Of course, this may look like a waste of time, because obviously I can’t immediately analyse samples and data. If I’m in the ward I can’t be working in the lab. But, for me this is just part of my job [...]. Many times my boss [the lab director] told me not to go to the ward, but this is too important for me. I feel compelled to be there, rather than risking that data be burnt. (Ethnographic field notes on Pina, experimental pharmacologist involved in department of clinical and experimental pharmacology - Human Ph@rma)

As this account highlights, there was a need to translate formal prescriptions into doable practical activities that could produce affordable biological materials and related evidences, thus enabling a shared understanding between the researchers and clinical staff involved in the study. Here, *precision* is an emerging property of a technologically dense environment that produces socio-technical conceptions of what should be “actionable” for precision medicine, and which attitudes and professional competencies are appropriate in bearing the combined management of the contextual factors inherent to the everyday organizing of the ward with the need to comply with laboratories rules.

Under this viewpoint, *precision* appear to be a distributed competence to produce organisational and inter-organisational work practices that ‘locate’ patients (potential or real) within a specific medical protocol. Therefore, *precision in practice* is socially constructed and shared among different professionals and embedded within the values, norms and rules operating in post-genomics medicine. In other words,

a “precision medicine” protocol results from the constant engineering of diverse elements (in the last vignette: biological materials, infusion pumps, sheets to document blood sampling procedures) that must be performed in, by and through situated practices by means of discursive (sharing a common cognitive framework with general nurses), material (to be able to repair / replace the infusion pump in case of failure) and social/organizing arrangements (negotiate with the lab director the legitimacy to stay in the ward to monitor infusion and blood sampling).

Another dimension of the learning process emerges regarding how to act as a “precision medicine practitioner” concerning the ability to manage unexpected events in coordination with other actors within the ward (e.g. infusion of a wrong dose of the drug). In this sense, the competent acting unfolds not only in performing specific habits and routines, but also in negotiating the technical plausibility of “precise” biomedical protocols, thereby facing uncertainties and technical intricacies. Indeed, Pina describes inter-laboratory cooperative paths in which the roots of laboratory work are prolonged to the point of becoming confused with clinical practice and with the innovation process *tout court*. On one hand, this form of cooperation lays the groundwork for patients’ care and assistance activities, and should not be considered ancillary to that of scientific research. On the other hand, it creates conditions for the transformation of clinical data from a merely descriptive element of a pathological condition to a constitutive and operative tool of lab life.

## 5 Final Remarks

Given the specificities of the context examined in this paper, I innervated a practice-based approach to learning with literature on the social manufacturing of expert knowledges and social studies of medicine not usually applied to the study of health professions, thus observing the shaping of multiverse healthcare practices as a problem of expert learning. In doing so, I have drawn attention away from abstract knowledges and cognitive processes by situating professionals in the health practices and communities through which knowledges and materials take on meanings. From this perspective, I proposed to analyse health practitioners as learners, who co-define a common understanding by integrating materials, values, local circumstances, and social relations of the people involved. Hence, learning to act as practitioners in precision medicine is strictly entangled with the local conditions in which it is learned, and “precision” is defined as such. In light of these considerations, I now distil and discuss three main dimensions related to the “learning” process as an entry point to explore healthcare professionals in the context of contemporary biomedicine:

- **The management of an evolving hybrid membership:** According to the discussed findings, learning is strictly intertwined with the socialising process; it is not merely a situated sharing of knowledges from senior members or “formal instructors” to junior ones. Senior members are also required to continuously learn to readjust their modalities of acting. In this sense, all participants are engaged in teaching and learning in practice, thus performing an hybrid membership, which largely exceeds formal prescriptions and tasks;
- **The management of professional transitions and the redefinition of organisational roles:** Learning is a socio-technical constructed process of positioning people and things with different form of agency. Indeed, learning is not a neutral process, but it takes place in biographical and historical landscapes that co-define peculiar forms and possibilities of participation and learning trajectories. In this sense, all agents are engaged in hybrid positioning between the role of instructor and that of apprentice, thus transforming themselves, and the contextual professional trajectory, by acting within a sociomaterial collective (an assemblage of things, people, knowledges and artefacts) of shared practices. Under this perspective, learning is not a set of discrete operations occurring within a specific perimeter, both of role or setting, but it is a constitutive dimension of a context of shared practices in itself — potentially disjointed from explicit pedagogical aims. Hence, learning implies contextually the definition and transformation of the organisational role, in terms of the defining the legitimisation of acting, range of autonomy and practical skills.



- **The management of conflictual / ambivalent circumstances:** Conflict and disagreement are strictly entangled in learning processes. In a context of action strongly characterised by a multi-disciplinary choreography, such as contemporary biomedicine, we observe diverse epistemological logic of actions and local “opportunistic necessities”, sometimes conflicting with each other. Clinicians, as the cultural and institutional professionals responsible for medicalising the patients’ bodies, are at once oriented to intervene in the configuration of laboratory life on the basis of their experiential and propositional knowledges, when the laboratory explicitly acts for the sake of the patient. On the other hand, laboratory practitioners may have or develop a different conception of how to produce clinically-actionable evidence with the aim of reinforcing their autonomy and organisational relevance. Observed from this perspective, learning implies negotiations of opportunities and interpretations of the different epistemic positions, thus actively questioning formal hierarchies and scientific requirements of the practice.

Learning — observed from a practice-based approach — is constitutive of every practice differentially distributed within a collective field in which participants have different perspectives, values and opportunities, even conflicting with each other. Accordingly, learning is a matter of defining and embedding in everyday work a set of abilities oriented to identifying and rendering different perspectives and epistemological regimens as mutually congruent, inherent to a heterogeneous field of practice. This implies the sharing of conventions on how to practise certain “operational purposes”, and how to gradually shift and readjust professional and biographical trajectories. In this sense, what should be considered “precise knowledges” in the context of contemporary biomedicine or, in more general terms, what is the “correct” way to act, is a matter of collective concern, since participants reflexively and actively define the consensus among potentially divergent perspectives. As a result, what I would finally stress is that learning is not a neutral activity, but a process that implies specific situated politics of knowledges, irreducible to a mere technical or functional dimension of doing something.

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