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What Philosophy for medical Education? Theoretical Issues in Practice

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ABSTRACT

Philosophy of science in medical education

Continuing the international debate on teaching philosophy to non-philosophers, we discuss why and how philosophy of science should be included in the training of young physicians. We detail what philosophy contents and tools should be delivered, stressing that professional philosophers should teach what biomedical students actually need. Some successful examples of philosophy courses in Italian Medical Schools are presented, in the light of which we argue that *jointly* considering research issues, training initiatives, academic curricula and institutional and organizational constraints can effectively foster a rethinking of the role philosophy can play in medical education – a role which might impact positively the future of both philosophy and biomedicine.

Keywords: Philosophy of science - Medical education - Conceptual analysis - Methodology

1. Introduction

In the last few years, a consensus has been growing around the role philosophy should play in the biomedical sciences, in particular in the education of the future researchers and clinicians. An international movement is taking shape in favour of the medical humanities – intended as philosophical reflection on biomedicine in its widest sense, encompassing critical reasoning applied to science, scientific methods and ethical reflections – as a means of providing a series of tools helping present and future practitioners understand the status, tasks, impact and implications of medicine and its practice. In the following we focus our attention mostly on the philosophy of science, which we intend in a wide sense, including also methodology of science and basic logic. Visibility of philosophy of science in the biomedical sciences over the last four decades has overall increased[1], and direct interactions have been fostered. In this wider scenario, for some time now philosophers and physicians have been debating possible mutual exchange to the benefit of both philosophy and medicine[2]. It has been argued both that physicians should be exposed to philosophy, and also that philosophers who wish to work in this area should be exposed to biomedicine. Medical doctors might find relevant works if appealing to philosophy[3] and, concerning this point, the title of a paper on *Nature* appears to be emblematic: "How philosophy is making me a better scientist"[4]. Philosophers, in turn, should have some sort of "intellectual internship in medicine", so-to-speak. The proper pursuit of the philosophy of medicine is a critical reflection on conceptual and theoretical aspects of medicine, and not the bringing of philosophical ready-made philosophical concepts to the medical mind. The philosopher of medicine analyses and discusses how medical knowledge is acquired, transmitted, used and changed. Wartofsky stresses – and we totally share this position – that, in order to elaborate significant and relevant reflections on biomedical research and clinical practice, philosophers of medicine need to acquire at least some basic, first-hand knowledge in the field: "philosophy needs to do an intership in medicine", since "the philosophy of medicine is a critical reflection on the theory and practice of medicine and not the bringing of philosophically ready-made concepts to the barbarian medical mind"[5]. Philosophers of medicine, in other words, should get acquainted with work in the lab and face conundrums emerging directly from forefront research, have a chance to visit a ward and get familiar with real clinical concerns, attend lectures and seminars in medicine, to grasp at least some of the fundamentals of medical knowledge and be thus able to genuinely interact with scholars and students in medicine. Reflections pursued in this spirit have taken the direction suggested by those pleading for "philosophy of science in practice", where philosophers are called to strongly interact with *actual scientific practice*.

The intensification of interactions between philosophy of science and biomedicine has also led to deeper reflections on the mutual role they can have in the education of experts in both fields. In what follow, we will focus exactly on which philosophy of science (and, of course, philosophy of medicine) topics should be considered relevant

for the curricula of biomedical students. We think that those topics should be considered as tools in the spirit already emphasized by Wartofsky, according to whom the proper pursuit of the philosophy of medicine, and of philosophy of science more in general, is providing the future researchers and clinicians with a set of tools that will help them cope with their work and the epistemological issues that can raise from it. Stated that we agree that specific philosophical reflections on science should contribute to the overall *education* of future clinicians and biomedical researchers, we should discuss what philosophy education should focus on, and why. These two questions will be addressed in section 2, while in section 3 some significant examples from the Italian scenario will be presented.

2. What philosophy, and why? Motivations and the general scenario

As is well-known, philosophical fields and perspectives currently available around the world are numerous and extremely varied. However, not all of them can be transposed wholesale to medical education. Contents and methods to be conveyed should fit the specific knowledge and skills to be acquired by young biomedical students to pursue their clinical or research career paths. In this setting, philosophy of science would seem the appropriate subject for inclusion in medical curricula[6]: as it will be argued below, also with the support of a few examples, it provides future researchers and clinicians with tools enabling them to understand the conceptual basis of their discipline, which in the end is always aimed at patients' benefit. Assuming this standpoint, philosophy teaching should not at all be considered a *mere add-on* to the biomedical programme, a smattering of "soft" humanities subjects in a technical course. What is necessary is an *integrated vision* whereby philosophical analysis of the concepts and methods underpinning biomedical research and clinical practice promote awareness among researchers and clinicians of the theoretical and practical implications of their work[7]. According to this integrative approach, the portion of philosophy of science taught must be thought of as a body of technical knowledge to be acquired by students as part of their basic education, to equip them with a deeper theoretical understanding of their discipline's methods, concepts, achievements and paradigms.

If – as we believe is the case – any debate on teaching philosophy to medical students should aim to prove philosophy is *genuinely relevant* for them, we have to start from what current biomedicine itself is indicating and from what researchers and clinicians themselves are asking. Indeed, several fundamental aspects of contemporary biomedicine pose philosophical questions pointing to the need for philosophy and methodology of science. Just to cursorily recall, contemporary medicine, with its emphasis on the molecular level, has opened up many areas of uncertainty and discussion concerning, for example, biomedical evidence; repeatability and reproducibility of biomedical results; status and methods of clinical trials; technological progress,

different concepts of health and disease; patient classification methods; diagnostic reasoning; computational tools to manage the deluge of data; and so on[8].

Over and above these epistemological issues, several foundational issues also need scrutiny since biomedical knowledge – whether from the lab or clinic – is heavily based on probability and statistics. During their training, students should therefore become aware of the key philosophical questions connected with the interpretation of a probabilistic result, fully grasping, for example, the difference between sensitivity and specificity, the positive and negative predictive value of a clinical test[9], the statistical bases of clinical trials[10], or of an epidemiological survey[11]. A correct understanding of such notions is a prerequisite both for an adequate interpretation and communication of scientific evidence and for a correct patient communication. Last but not least, competence in philosophy would also help avoid reasoning fallacies, which jeopardize interpretations of scientific results and clinical tests. Philosophical awareness of correct argumentation would improve appropriate reasoning in both the research setting and clinic – where wrong reasoning can have devastating effects on patients' lives[12]. The medical student is asked to know that reasoning – whether probabilistic or otherwise – has its own rules and that there are many conceptual issues underlying the statistical tools and protocols adopted. Correct understanding of these aspects is not something proposed abstractedly by philosophers. It is the basis on which the daily practice in a lab or in a ward is based and it is something asked by senior scientists and senior clinicians, as the authors recalled above in the quotation clearly point out.

With summing up, acquiring a few philosophy of science "theoretical passkeys" should provide future researchers and clinicians with the tools to adequately address questions concerning the method, validity and applicability of biomedical knowledge, which are crucial both for the pursuing of medical research and for patients' care. Considering what above, it seems that in the biomedical curriculum there should be at least topics belonging to philosophy of science (intended in a wide sense) such as critical thinking in clinical settings (that is, contextualized basic logic); elements of scientific methodology; philosophical foundations of probability and statistics concerning clinical tests, clinical trials, foundations of epidemiology and probabilistic prognoses. As remarked, these topics are not suggested by philosophers of science, but rather invoked by the researchers and clinicians themselves, in dialogue with philosophers. With a motto, we could say that "We – the philosophers – should not teach what we know or like, but what the biomedical students need for their profession"; and – as shown above – in the scientific literature there are clear indications of the subjects needed. The acquisition of some conceptual and formal tools is likely to foster critical reflections, and hence enhance the understanding of different situations and contexts. However, empirical studies on how, for instance, formal dilemmas and thinking in terms of possible worlds actually impact clinical work are yet to come.

Of course, both, on the one hand, philosophers and, on the other hand, researchers and clinicians are entitled to evaluate which philosophical topics should be taught. Relevance for biomedical practice should guide educational choices. In certain cases, the topics could be indicated from inside medicine, as it happened, for instance, with the discussions mentioned above. In other cases, the philosophers should argue for the relevance of some issues to be taught and suggest their implementation in the biomedical curricula, as, for example, has occurred with the debate on statistical and mechanist evidence by the EBM+ group, which aims to translate philosophical work into medical guidelines. In the volume by Parkkinen et al. (2018)[13] a large number of actual cases are presented, both concerning populational and individual health issues, that can benefit – according to the authors – from incorporation of some mechanistic evidence into the analyses provided in the spirit of EBM. The volume does not provide just general philosophical principles, but also some protocols for gathering, evaluating, grading and using evidence for the purposes of assessing external validity of tests and efficacy of treatments. Core theoretical ideas on the interpretation of trials and on what mechanistic evidence is and is for are translated into practical tools and guidelines for practitioners in medical fields and professionals in health-related policy (see e.g. ch.4, presenting a "Mechanisms in Clinical Research Appraisal Tool", "Mechanisms in Basic Research Appraisal Tool", and "GRADE-Style Tables for Mechanism Assessment"). Along the same lines, reflections on the importance of mechanistic evidence have been put forward by the EBM+ group also in relation to the understanding of Covid-19 behavior, related research and interventions, which have clear practical impact[14].

Another example of philosophical relevant discussions is provided by the health/disease debate, which is no doubt authored mainly by professional philosophers, but by no means irrelevant for medicine. On the contrary, its main strands have a number of implications for practical matters (diagnoses, choice of treatments, social consideration, etc.), and whenever, for instance, disability or psychiatric disorders are at stake – as variations in the different versions of the DSM show very clearly. Issues regarding what counts as mental disorder, whether definitions and classifications of psychiatric disorders necessarily comprise normative elements and social values, what variability of nosographies depends on are widely debated within the mental health sciences, and the number of works by scholars in that field appealing also to philosophical tools and views has been increasing – as a number of joint works on psychiatric disorders with contributions from psychiatrists and philosophers, also on specific disorders, proves[15]. Philosophy of psychiatry provides numerous eminent examples of interactive work on epistemological issues. Among others, scholars such as K. Kendler, J. Parnas and P. Zachar are examples of prominent researchers in the mental health sciences who have also addressed deep philosophical issues on definition and classification of mental disease, diagnostic reasoning, explanatory levels, etc., and have done so by means of

close exchanges with philosophers of science. But epistemological inquiries are by no means confined to academic scenarios, as proved by many works[16] that have been carried out for quite some time now from within psychiatry to test attitudes of psychiatrists, trainees in psychiatry and psychiatry nurses with respect to concepts of mental illness, ways in which they are modeled, etiological explanations, and the like. Such studies have stressed the importance of how medical students conceptualize psychiatric illness, and how they identify relevant factors along the biological-psychological spectrum, for aspects having to do, in the end, with treatment.

All such studies have been explicitly driven by the conviction that the adoption of different models and concepts directly impacts treatment practice, clinical decision-making the management of multi-agency teams and power relations both in the clinician-patient relation and within the group of the practitioners involved, with different roles.

Another way to stress the importance of issues on defining and classifying a given condition as pathological, and then, on that basis, on providing a diagnosis in a whole range of medical fields, both in psychiatry and elsewhere, is by starting from the students' own background. As Louhiala[17] suggests, we can ask them: "What is common among the following diagnoses: pneumonia, hypertension, fibromyalgia, depression, hypomania and schizophrenia?". There is neither a simple nor a 'right' answer to this question and the point, on the other hand, the students themselves could notice how their working field produces philosophical questions. In sum, various papers reporting on first-hand teaching experience show how encouraging students to address issues concerning, for instance, the nature of illness and disease, the lumping/splitting problem, the type/token relation can then impact how they face diagnoses.

A genuine and effective integration of philosophical standpoints into medical education is going to need collaborative exchanges between experts in the respective fields. Pursuing interdisciplinarity for real-world problem solving – as problem solving in medicine surely is – requires fostering close collaborative work between scholars, as well as responsible of education systems[18]. From this perspective, philosophy of science becomes a necessary part of a complete and integrated educational program – a part whose topics are chosen by philosophers, researchers and clinicians in strict dialogue.

3. Philosophy in medical education in Italy: the current situation, and some interdisciplinary initiatives

Given the discussion above, what is the current situation in biomedical education? Things change significantly from one place to another[19]. Let us just recall a few cases. With respect to teaching, examples are provided both by wide initiatives – as the R3 Graduate Science Initiative "Critically 'Thinking Science'" at Johns Hopkins University (Maryland, USA) led by Gundula Bosch – or by the insertion of specific courses into curricula – as, e.g., the courses of Medical Foundation and Medical Reasoning delivered by Ted Poston to pre-medical students at the University

of Alabama; and the course on "The science and its philosophy", delivered by the Department of Biology at the University of Lund (Sweden), and mandatory for all PhD students in biology. Moreover, the research group "Theory and Method in Biosciences" (University of Sydney) has opened interdisciplinary PhD scholarships (in History and Philosophy of Nutrition Science), as the Institute for Philosophy of Biology and Medicine at the University of Bordeaux has.

Nevertheless, examples from Italy and Spain (the countries we know better) show a picture of the room devoted to philosophy in medical education in those countries that is less than ideal. Reviewing the Bachelor of Medicine curricula published on the websites of 42 Italian and 39 Spanish universities for the academic years 2014-2015 (Spain) and 2015-2016 (Italy), Orefice, Pérez, and Baños (2019)[20] report that all included at least one humanities subject. The subjects appearing most frequently are: history (91%, mainly history of medicine), philosophy (81%, mainly bioethics), anthropology (28%), and literature (12%). The number of compulsory courses in philosophy proves from this study to be significantly higher than the number of elective ones. However, they are not equally distributed throughout the medical students' curriculum – with a prevalence of courses in philosophy in year 1 and 6 in Italy, and 1, 2 and 3 in Spain, and very few cases in which they are delivered also in the other years. Further analysis also shows the philosophy courses to carry an extremely limited number of credits and often to have been simply imported from different degree subjects.

Have there been any subsequent systematic improvements in the overall situation in Italy? It would appear not. A look at some major universities – Bologna, Florence, Naples-Federico II, Padua, Rome-La Sapienza, and Turin – shows a very fragmented heterogeneous scenario, where each university has slightly different strategies on the humanities subjects to include in medical education. Differences in curricula notwithstanding, a few general features do nonetheless repeat. The humanities courses tend to be delivered mostly in the first year and then disappear from the curriculum. Courses are assigned a very limited number of credits, and therefore number of lessons. Most are elective and, as already mentioned, courses often originate within the framework of another university degree subject. Bioethics, for example, might well be part of "Drugs and Bioethics" or "Ethics and Behavioural sciences". History of Medicine appears the most frequently delivered course, while Philosophy more often than not features as "Bioethics". Very few courses are offered on epistemology and philosophy of science, with some universities offering none at all.

Let us also recall that, despite this heterogeneous and somewhat discouraging scenario, there are some examples in Italy of successful interactions of philosophy and biomedicine, with applications in educational scenarios. Several Medical Schools are showing growing interest in philosophy subjects and methods, while some Philosophy Schools are beginning to provide philosophers of medicine and ethicists with first-hand biomedical experience. In what follows three examples of philosophy-of-science teaching to

non-philosophers are presented in which the Authors were directly involved, albeit in different ways, that could provide hints for wider implementation. Although surely not perfect, such cases are worth mentioning in virtue of some relevant outcomes they had.
The first philosophy-of-science teaching experience is that currently provided by the Medical School of the University of Ferrara, where for several years now the compulsory curriculum has included a significant philosophy component. Since 2016, medical students have integrated standard biomedical and clinical training with a humanistic education where philosophy of science and ethics are an important part. In particular, second year students follow a *Medical Humanities* course made up of four modules:
– *Legal Medicine* (16 h): basic legal implications of clinical practice;
– *Clinical Psychology* (8 h): a first overview of the doctor–patient relationship;
– *History of Medicine* (8 h): the historical development of key medical practices;
– *Clinical Critical Thinking and Applied Ethics* (32 h): how to correctly infer and argue; fallacies to be avoided; writing a paper and defending a thesis; the scientific method; the epistemological role of empirical results; constructing a good ethical position; and coping with ethical problems, etc.
In the third year, students have to attend *Diagnostic Methodology* (25 h), focusing on the epistemological meaning of sensibility and sensitivity, positive and negative predictive values, ROC curve, the *p* value, confidence interval, clinical relevance, type I and II errors, Bayes theorem, and the frequentist and Bayesian approaches, etc.
In their fifth year, students follow *Ethics in Practice* (16 h): a clinician (a nephrologist, gynaecologist or surgeon, etc.) presents a real clinical case that raises an ethical/existential problem; students discuss the case-study under the direction of an ethics expert who frames it within the international debate. This proved an effective way to have experts from different fields pursue *genuine co-teaching*: in the same lecture, the clinician would provide a detailed report on an actual problematic case, which would then be discussed by adopting the tools put forward by the bioethicist, with joint discussions involving the two different experts and the students (who, in turn, would come from different disciplinary backgrounds). The Ferrara model aims to raise awareness among students (i.e., future researchers and clinicians) of the philosophical aspects and related ethical issues their work will involve. The goal is to provide a *joint* ethical, methodological and philosophical education as *a compulsory* component *throughout the entire Bachelor degree course in medicine*.
The second education experience we want to recall is the Winter School in "Health Sciences and Bioethics", organized at the University of Bologna by the Inter-University Research Centre PhilHeaD (https://philhead.org/) in January 2020, 2021, 2022 and 2023. Although targeting medical students, the school is also open to students of the other life sciences, philosophy and law. The project springs from the longstanding collaboration between a few medical doctors and philosophers at the University of

Bologna and their shared view that philosophical tools are essential to address the range of complex and challenging issues that are part and parcel of daily activities in the lab and on the ward. Although not claiming to provide a complete toolbox, the Winter School's programme has been designed to ensure that (especially medical) students are exposed in a continuous and coordinated fashion to philosophical, methodological and ethical issues inevitably arising in medicine. The Winter School brings together students from different fields but also senior lecturers from different disciplinary backgrounds – e.g., genetics, molecular biology, gynecology, neurology, anatomical pathology, criminal law, philosophy of science, moral philosophy, philosophy of law, and bioethics –, with the aim of prompting joint discussion in the belief that direct mixed-background student-scholar exchange is an optimal way of facilitating the integration of the different languages and disciplinary methods. Topics offered to students touch on questions concerning health and disease, doctor-patient relations, clinical decisions, reproduction and biotechnologies genetic diseases and genome editing, transplantation, and end of life. Just to make an example, a detailed explanation was provided by the genetic of CRISPR/Cas 9, which was then discussed adopting epistemological and ethical tools. Attending students in philosophy benefitted from the scientific part, attending students in medicine and biotechnology got familiar with philosophical tools.

The third significant teaching experience we wish to recall is the "Foundations of the Life Sciences and their Ethical Consequences" (FOLSATEC) doctorate programme, which ran from 2006 to 2015 thanks to the joint efforts of the Department of Health Sciences of the University of Milan and the European Institute of Oncology (a comprehensive cancer hospital). Although not initiated with the specific aim of providing clinicians or biomedical researchers with training in philosophy, but rather to give philosophers and ethicists a strong biomedical and clinical grounding, the programme proved extremely effective in *both* directions: it was rolled out in a biomedical environment whose focus was molecular oncology research and molecular biology higher education, and allowed a close and continuous exchange between philosophy and biomedicine. An international PhD programme aimed at creating scholars who, although from the humanistic disciplines, were also skilled in the fields of biomedical research and clinical practice, FOLSATEC aimed to: (a) leverage the conceptual understanding of the philosophical foundations and ethical implications of biomedical research and clinical practice; and (b) improve patient quality of life through empowerment and by growing practitioner awareness of the humanistic issues at stake. The programme's core target was to train young biomedicine philosophers and ethicists by having them work side-by-side with top scientists and meet patients at the bedside. Designed, structured and implemented in the wake of trans-disciplinary reflection and based on educational research principles, the PhD programme aimed to: (i) address and analyse a range of bioethical and societal issues in-depth; (ii) explore the philo-

sophical foundations of molecular biomedicine and clinical practice; (iii) refine logical/analytical/philosophical skills to better achieve (i) and (ii); (iv) become acquainted with lab or clinical practice; (v) conduct genuinely interdisciplinary research that effectively combines scientific and humanistic subjects, interacting with (and observing the work of) top scientists and experienced doctors; and (vi) learn how to tackle the practical, cultural, and socio-political impacts that biomedicine and scientific advances can engender. All these points were addressed ultimately to improve the condition of patients.

The curriculum was constructed along two different lines to allow for reciprocal exchange. On the one hand, it aimed to provide a theoretical and empirical scientific education to students coming from a humanistic background; on the other hand, to teach philosophy to students from a scientific background. The goal was to ensure both groups achieved a fairly homogeneous level of knowledge, with no group in a privileged position compared to the other, thereby creating a balance that would foster mutual communication. To this end, students in the first two years received very broad training to fill the gaps in either philosophy or science. They also had hands-on experience working with scientists engaged in frontier scientific research in real wet or dry labs or on real wards. In this way, not only were the students concerned with scientific practice, they actually "practised science", working alongside scientists. The first two years entailed about 250 "classroom" hours per year[21]. The curriculum also had a strong impact on biomedical researchers, who were made to interact with the young philosophers and ethicists and were exposed to different theoretical views on their activities.

The PhD programme was made possible thanks to a series of extremely favourable circumstances: the particular scientific environment whose prestigious laboratories and facilities were available to scientists and philosophers; specific boundary conditions, not least a favourable economic situation, cultural openness, and dedicated and cooperative senior philosophy scholars, scientists and clinicians. Although started as a PhD programme in the humanities, it led to continuous far-reaching input from and exchange between the biomedical and philosophy fields. Participants gained a deep understanding of the relevance of up-to-date medical knowledge to ensure adequate reflections in philosophy of science and bioethics, and an appreciation by biomedical researchers in labs and practising clinicians of the relevance of philosophy of science and bioethics to their daily work. FOLSATEC crucially contributed to the education of students with a background in philosophy who then became able to work also on pretty technical matters in medicine, and to the education of students in medicine who became competent and sensitive on philosophical aspects[22]. At the same time, students at FOLSATEC had a chance to very closely interact with scientists working at the European Institute of Molecular Oncology, and then to act as co-authors in papers in cancer research. In such a context, students conveyed philosophical standpoints and

introduced researchers to epistemological concerns and tools, which were then taken into account also in joint published works[23]. Work pursued within the FOLSATEC-IEO collaboration had also outcomes which proved very beneficial – and directly so – for patients' care. To mention just one, let us recall the revision of the traditional informed consent, which was successfully put forward trough a careful analysis of the quality and amount of information needed by patients for their consent to be truly informed, and the adequate ways of conveying information about risk rated and non-predictable lines of research[24].

Can a tentative lesson be draw from these initiatives that might encourage more general rethinking of the strategies to promote the teaching of philosophy of science and applied ethics in medical education? Although different, all three cases rolled out *jointly* designed and delivered programmes that *directly and systematically* exposed biomedical students and practitioners to philosophical concepts and methods that had direct relevance for their studies or work. However, if the role of philosophy of science and ethics in the clinic and research lab is to be acknowledged as an important component of medical education, we have to understand that it is not just a question of what subjects are included and how they are taught. It is also a matter of how the different disciplines are made to interact. In other words, it is not just a question of the subjects taught. There is a need for far-reaching *collaboration between scholars* of medicine and philosophy, who must be willing to *discuss curricula together*, and then to *teach together* – e.g., discussing case studies – within the *same* curricula. Close collaboration will allow better tailoring of topics to students' interests and needs – which might well differ depending on whether they aim to become geneticists, psychiatrists, surgeons or epidemiologists, etc. Enhancing the impact of philosophy of science and ethics in medical education can be more effectively pursued if there is reciprocal cultural and institutional change, i.e., when also some teaching of the health sciences is delivered as part of the philosophy curricula. Not only will this strengthen interdisciplinary relations, it will also prepare philosophers to become future lecturers in Schools of Medicine. In conclusion, if philosophy is to play a relevant role in medical education, that might be better fostered through *mutual* exchange between scholars in the different fields. For example, Laplane et al. (2019)[25] recommend philosophers be given a greater voice in medical conferences, and vice versa, that philosophers be hosted in science labs or affiliated to science departments, but also that scientists work in philosophy departments, and that PhD students be co-supervised by representatives from both disciplines, etc. Both sides will surely benefit from *reciprocal* exchange.

4. Quod optimus medicus sit quoque philosophus

What and whom do philosophy of science serves when it is included in medical education, and what strategies should be put in place to ensure effective results that meet the assigned goals? "That the best physician is also a philosopher" was already claimed

by Galen[26]. But even if we acknowledge the many pressing philosophical issues raised by medical practice and research today, we must also admit the inevitable theoretical and practical constraints to introducing philosophy-of-science teaching – not least the legal regulations governing curricula. Hence the need for close partnership between the two academic sectors to bring about a substantive mindset change.

It is not just a question of a philosopher of science being in favour of teaching her specialist discipline in a medical education setting. Integrating philosophy subjects in medical education requires revision of the curricula as well as the regulations governing content, which in turn means close collaboration with curricula drafters. How thoroughly would curricula have to be re-structured? Are some curricula in some parts of the world more malleable than others in this respect? Could some useful lessons be drawn by systematically comparing them? Consensus regarding some philosophical training for scientists must also go hand in hand with reflections on early careers and academic frameworks. Some official recognition of trans-disciplinary studies should be warranted from the start. For example, trans-disciplinary studies should provide an advantage in terms of grants, fellowships and early career research projects where a knowledge of ethics and conceptual competence could make a difference. The examples given in Section 3 clearly suggest that successful "mixed" education could be promoted by exercises requiring the *contemporary presence in class* of medical and philosophy lecturers – and, where possible, also of students from both disciplines. This interdisciplinary exercise should be evaluated not only per se, but also measured in terms of the benefits accruing to the disciplines themselves by being induced to assess their own relevance.

Although supported by conceptual arguments and specific requests from the biomedical field itself, our position on philosophy teaching in medical education is admittedly not corroborated by empirical studies directly confirming a causal relationship between the teaching of certain disciplines, their assimilation by biomedical practitioners, and a resultant effective improvement in research and patient care. It is to note that it is extremely difficult to realise this kind of study for obvious statistical reasons, however some results are beginning to appear[27]. On this aspect, it should be noted that there are no studies on the efficacy of the teaching of physiology or molecular biology to the medical students either. Yet these topics are considered necessary for a proper and complete medical curriculum. Why should not be given the same value and role to the philosophy of science topics, since – as seen – they are necessary?

To conclude, it should be noted that the real integration, at least at educational level, between (certain) philosophy of science and medicine is necessary if the former wants to be released from the "quarantine"[28] their ancillary role seems to condemn them to. Integration can only come about if we remember that philosophy of medicine should be committed to ask questions about what medicine itself is asking. It follows – we remark – that the questions we ask as philosophy professionals must be pertinent to the various branches of the biomedical profession

Drafting medical curricula that includes philosophy-of-science teaching is without doubt a complex task[29]. An exercise in bringing together expertise from different fields involves the ability to connect, translate and establish links between disciplinary knowledge, and to understand and explain the role of the different fields in how knowledge is produced and used. However challenging and difficult to pursue (e.g. due to the lack of a common language and shared understanding of concepts), such an enterprise performed at the crossroad of philosophy of science and medical education is going to have (at least) three positive effects: (i) provide future researchers and clinical practitioners with key theoretical tools pertinent to their profession; (ii) improve decision-making processes and patient care; (iii) facilitate collaboration between senior and junior medical practitioners and philosophers. Indeed, it is hoped that a virtuous circle of collaboration can be triggered in the spheres of research – where collaboration is already well underway – and teaching – where some headway is being made, albeit in a somewhat piecemeal fashion. We believe that organizational, institutional, educational, cognitive and epistemological aspects should not be given a hierarchical priority but would be better addressed *together*. *Jointly* considering research issues, training initiatives, and institutional and organizational early career conditions will encourage a rethinking of how philosophy (or at least, a certain kind of philosophy) can be related to medicine and so have an impact on the future of both.

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Giovanni Boniolo and Raffaella Campaner have contributed equally to this paper.

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3. On this regard, it is worth remembering what the former Editor of the *British Medical Journal* wrote: there is the "conviction that healthcare, which is suffering an existential crisis, badly needs the help of philosophers", and: "science cannot, however, answer some of our most important questions, and those of us educated in science have to be wary of thinking it might. Philosophy can't answer most of them either, but it provides a means of rigorous and critical thinking and examination that can keep us from hubris, something to which

medicine is prone" (Smith R, Medicine's need for philosophy. BMJ 2016;https://blogs.bmj.com/bmj/2016/04/08/richard-smith-medicines-need-for-philosophy/. April 8 2016).

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6. See e.g. Grant VJ, Making room for medical humanities. Medical Humanities 2002;28:45-48; Boniolo G, Campaner R, Coccheri S, Why include the humanities in medical studies? Internal and Emergency Medicine 2019;14:1013-1017; Boniolo G, Campaner R, Life sciences for philosophers and philosophy for life scientists: What should we teach? Biological Theory 2020;15:1-11.
7. See Evans, M H, Greaves D, Exploring the medical humanities. BMJ 2019;319:1216; Boniolo G, Chiapperino L, Rethinking Medical Humanities. Journal of Medical Humanities 2014;35:377-387.
8. See Baker M, Is there a reproducibility crisis? Nature 2016;533:452-54; Boniolo G, Nathan M (eds), Philosophy of molecular medicine: Foundational issues in research and practice. New York: Routledge; 2017; Darrason M, From the concept of genetic disease to the geneticization of diseases. Analyzing and solving the paradox of contemporary medical genetics. In: Boniolo G, Nathan MJ (eds), Philosophy of Molecular Medicine: Foundational issues in research and practice. New York: Routledge; 2017. pp. 37-77; Darrason M, Zelek L, La médecine personnalisée en cancérologie: vers une complexification des stratégies thérapeutiques? In: Amsellem N (ed.), Le cancer: un regard sociologique: Biomédicalisation et parcours de soins. Paris: La Découverte; 2018. pp. 87-104; Badinella M M, Bracco C, Magnino C, Ambrogio L, Fenoglio L, Why include the humanities in medical studies? Comment. Internal and Emergency Medicine 2020;15:525-526.
9. See Loong TW, Understanding sensitivity and specificity with the right side of the brain. BMJ 2003,27;327(7417):716-9.
10. For example, there is little understanding on the philosophical significance of the p-value, and how this relates to the confidence interval and clinical significance. On this topic, there is a huge literature in the scientific journals (see, e.g., Goodman SN, Toward evidence-based medical statistics, 1: The P value fallacy. Annals of Internal Medicine 1999;130:995-1004; Nuzzo R, Scientific method: statistical errors. P values, the 'gold standard' of statistical validity, are not as reliable as many scientists assume. Nature 2014;506:150-152; Amrhein V, Scientists rise up against statistical significance. Nature 2019;567(7748):305-307). There is also a tutorial on *Nature Methods* (www.nature.com/articles/nmeth.2698) emphasizing its statistical relevance but its clinical neutrality. This is a chapter of a wider tutorial on the foundations of probability and statistics that *Nature Methods* has proposed to the life scientists: "Since September 2013 *Nature Methods* has been publishing a monthly column on statistics called <Points of Significance>. This column is intended to provide researchers in biology with a basic introduction to core statistical concepts and methods, including experimental design" (www.nature.com/collections/qghhqm/pointsofsignificance).

11. Unfortunately, many clinicians do not have a proper comprehension of the philosophical foundations of epidemiology. For example, Wegwarth O et al., Do physicians understand cancer screening statistics? A national survey of primary care physicians in the United States. Ann Intern Med 2012;156:340-349) have shown that about 76% of the American clinical oncologists do not have a clear idea of what survival rates are.
12. See, e.g. Elizondo Omaña RE et al., Teaching skills to promote clinical reasoning in early basic science courses. Anat Sci Educ. 2010;3(5):267-271; Gay S, Bartlett M, McKinley R, Teaching clinical reasoning to medical students. Clin Teach 2013;10(5):308-312; Amey L, Donald KJ, Teodorczuk A, Teaching clinical reasoning to medical students. Br J Hosp Med 2017;78(7):399-401.
13. Parkkinen VP et al., Evaluating evidence of mechanisms in medicine. Principles and procedures. Dordrecht: Springer; 2018.
14. See Aronson J et al., The use of mechanistic evidence in assessing coronavirus interventions. Journal of Evaluation in Clinical Practice 2020;1-10. DOI: 10.1111/jep.13438.
15. This is witnessed by a range of joint publications with colleagues in philosophy, such as the series of four volumes on "Philosophical issues in psychiatry", and the recent volume "Levels of analysis in psycpathology", edited by Kendler, Parnas and Zachar. All such volumes clearly show close interactions, with contributions from different standpoints, psychiatric and philosophical, and commentaries from the other field.
16. E.g. Colombo A et al., Evaluating the influence of implicit models of mental disorder on processes of shared decision making within community-based multi-disciplinary teams. Social Science & Medicine 2003*;*56:1557-1570; Miresco MJ and Kirmayer IJ, The persistence of mind-brain dualism in psychiatric reasoning about clinical scenarios. American Journal of Psychiatry 2006;163:913-918.
17. Louhiala P, Philosophy for medical students-why, what, and how. Medical Humanities 2003;29:87-88, 88.
18. On difficulties and prospects in interdisciplinarity for real problem solving, see Boon M, van Baalen S, Groenier M, Interdisciplinary expertise in medical practice: Challenges of using and producing knowledge in complex problem-solving. Medical Teacher 2019;41(6):668-677.
19. A detailed review of medical school curricula in Canada, the UK and the US is provided in Howick J. et al., Do medical schools teach medical humanities? Review of curricula in the United States, Canada and the United Kingdom. Journal of Evaluation in Clinical Practice 2021;1-7;DOI: 10.1111/jep.13589.
20. Orefice C, Pérez J, Baños JE, The presence of humanities in the curricula of medical students in Italy and Spain. Educ Med.2019;20(S1):79-86.
21. The topics were Bioethics, Biolaw, Computation for Philosophers, Epistemology, Evolutionary Biology, Foundations of Ethics and Bioethics, Foundations of Probability and Statistics, General Philosophy of Science, History of Biomedicine, Logic and Rhetoric, Philosophy of the Life Sciences, and STS and the Life Sciences. Moreover, they were also required to follow some classes of the other two PhD programmes, in particular Bioinformatics, Developmental Biology and Animal Models, Fundamental Principles in Molecular Oncology, Genomics and Proteomics, and Scientific Methodology.
22. Just to recall a few examples, let us mention, on the one hand, young scholars such as Silvia Camporesi and Fridolin Groß, who, starting from a background in the sciences, acquired philosophical tools and employed them in works on, e.g., theoretical description and characterization of clinical investigations, definition of disease/injury/

well-being, decision making for cancer patients, cell reprogramming. See e.g. Sullivan RJ et al., Delivering affordable cancer care in high-income countries. The Lancet Oncology 2011;12(10):933-980; Maddock C et al., Online information as a decision making aid for cancer patients: Recommendations from the Eurocancercoms project. European Journal of Cancer 2012;48(7):1055-1059; Karkazis KR, Jordan-Young R, Davis G and Camporesi S, Out of bounds? A critique of the new policies on hyperandrogenism in elite female athletes. The American Journal of Bioethics 2012;12(7):3-16; Franklin S, Ospina Betancurt J, Camporesi S, What statistical data of observational performance can tell us and what they cannot: the case of Dutee Chand v. AFI & IAAF. Br J Sports Med 2018;52(7):1-2.

23. See e.g. Giaimo S, d'Adda di Fagagna F, Is cellular senescence an example of antagonistic pleiotropy? Aging Cell 2012;11:378-383; Brozzi A, Urbanelli L, Germain PL, Magini A, Emiliani C, hLGDB: a database of human lysosomal genes and their regulation. Database 2013; bat024, https://doi.org/10.1093/database/bat024; Casola S et al., Germinal center dysregulation by histone methyltransferase EZH2 promotes lymphomagenesis. J Clin Invest. 2013;123(12):5009-5022; Fragola G, Germain PL, Laise P, Cuomo A, Blasimme A et al., Cell reprogramming requires silencing of a core subset of polycomb targets. PLOS Genetics 2013;9(2): e1003292. https://doi.org/10.1371/journal.pgen.1003292.
24. See Sanchini V et al., A trust-based pact in research biobanks. From theory to practice. Bioethics 2015;DOI:10.1111/bioe.12184.
25. Laplane L et al., Why science needs philosophy. PNAS 2019;116(10):3948-3952.
26. Brain P, Galen on the ideal of the physician. SA Mediese Tydskrif 1977;936-938. See also Kühn CG (ed.), Galeni Opera Omnia. Leipzig: Cnobloch; 1964. Reprinted, Hildesheim, Olms.
27. See e.g., Macnaughton J, The humanities in medical education: Context, outcomes and structures. J Med Ethics: Medical Humanities 2000;26:23-30; Wershof SA et al., Evaluating the impact of the humanities in medical education. Mt Sinai J Med. 2009;76: 372-80; Macpherson K, Owen C, Assessment of critical thinking ability in medical students. Assessment & Evaluation in Higher Education 2009;35: 41-54; Athari ZS, Assessing critical thinking in medical sciences students in two sequential semesters: Does it improve? J Educ Health Promot 2013;2:5; DOI: 10.4103/2277-9531.106644; Lee SY, Lee SH, Shin IS, Evaluation of medical humanities course in College of Medicine using the context, input, process, and product evaluation model. J Korean Med Sci. 2019;34:163; DOI: 10.3346/jkms.2019.34.e163.
28. Stempsey WE, The quarantine of philosophy in medical education: Why teaching the humanities may not produce humane physicians. Medicine. Health Care and Philosophy 1999;2:3-9.
29. Pellegrino ED, The humanities in medical education entering the post-evangelic era. Theoretical Medicine 1984;5:253-266, paragraphs 4 and 5.1

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