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An MD-PhD program in Brazil: students' concepts of science and of common sense

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Abstract

In 1995, a pioneering MD-PhD program was initiated in Brazil for the training of medical scientists in experimental sciences at the Federal University of Rio de Janeiro. The program's aim was achieved with respect to publication of theses in the form of papers with international visibility and also in terms of fostering the scientific careers of the graduates. The expansion of this type of program is one of the strategies for improving the preparation of biomedical researchers in Brazil. A noteworthy absence of interest in carrying out clinical research limits the ability of young Brazilian physicians to solve biomedical problems. To understand the students' views of science, we used qualitative and quantitative triangulation methods, as well as participant observation to evaluate the students' concepts of science and common sense. Subjective aspects were clearly less evident in their concepts of science. There was a strong concern about "methodology", "truth" and "usefulness". "Intuition", "creativity" and "curiosity" were the least mentioned thematic categories. Students recognized the value of intuition when it appeared as an explicit option but they did not refer to it spontaneously. Common sense was associated with "consensus", "opinion" and ideas that "require scientific validation". Such observations indicate that MD-PhD students share with their senior academic colleagues the same reluctance to consider common sense as a valid adjunct for the solution of scientific problems. Overcoming this difficulty may be an important step toward stimulating the interest of physicians in pursuing experimental research.

Key words: MD-PhD program evaluation; Concept of science; Common sense concept; Medical research training; Methodological triangulation

Challenges for the training of medical scientists

Scientific progress requires professionals who are prepared to act in a multidisciplinary manner. Medical research increasingly requires more professionals capable of investigating diseases from their molecular basis to their clinical manifestations (1,2). Paradoxically, teaching in Brazilian universities is still relatively unsuccessful at producing MDs who are interested in bridging this gap.

Up to 1970, there were relatively few undergraduate courses for basic science and most of the biomedical disciplines in Brazilian universities were taught in medical schools, which attempted to integrate the basic and clinical courses. Thus, the openings for trainees and for future basic science professors were filled mainly by physicians. Nowadays, however, these professionals are a minority in these departments. Up to 1985, 52% of the faculty recruited by the Biophysics and Medical Biochemistry Institutes of the Federal University of Rio de Janeiro (UFRJ) were physicians. That number dropped to 25% in 1990. In more recent faculty hiring, the number of physicians has fallen dramatically to <5% in these institutes. In 1985, medical students accounted for 35% of the undergraduate research trainees. Currently, they represent less than 5%. Such a reduction will have a significant impact on the graduate programs and teaching staff.

Medical courses are the most sought after and select the candidates with the best academic performance; nevertheless, these students are not accepted as trainees in basic science. The lack of interest is due to the heavy load of compulsory courses, which reduce the time for such optional activities, as well as to the tendency among these students to abandon laboratory work as the course advances or after graduation. Thus, advisors would rather invest in students of other courses that ensure their presence in the laboratory for longer periods of time. Over time, the number of advisors with an MD degree has fallen off, closing the cycle

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of access to medical research training. Moreover, it is also true that at the end of the 6-year course and after a 2-year residency or specialization period, even a young physician can already enter the job market with good pay.

In contrast, it is only several years after graduation, and facing tough competition to get into the best graduate programs, where he or she will receive a low-paying fellowship, that the MD with postdoctoral training will be able to compete effectively for a faculty position in basic science. His pay will be lower than for those who have chosen clinical or surgical practice. And last but not least, the academic structure of Brazilian universities prevents their faculties from acting simultaneously in a basic discipline and in a clinic. The arduous investment of the medical researcher culminates in losing his feeling for clinical work as a consequence of the many institutional segmentation obstacles, still present in Brazilian universities.

The MD-PhD programs

Many countries have undertaken initiatives to increase the integration between basic sciences and medical research. Specifically, we highlight the MD-PhD programs of American universities, which were created in order to increase the number of medical researchers (3,4). The American academic structure has the flexibility to implement novel educational programs proposed by individual universities. Candidates are initially selected to study medicine and in a second stage, to enter the MD-PhD program. Similar programs are being implemented in the UK and other countries (5), albeit on a smaller scale.

The MD-PhD program receives considerable government support in the US. In 1964, the National Institutes of Health (NIH, USA) supported MD-PhD programs in three medical schools through the Medical Scientist Training Program. Nowadays, ~40 institutions are supported, involving ~826 students under training. Seventy-five additional US medical schools offer this double training to students using the resources of the medical school. Nearly 2.5% of American medical students are enrolled in MD-PhD programs (6).

Medical students accepted into the American MD-PhD program follow a different and more comprehensive academic program than those who are only studying medicine. They alternate periods in basic and clinical disciplines and, upon completion of the course, they receive two degrees, Doctor of Medicine (MD) and Doctor of Science (PhD). However, more important than the MD-PhD title is the exceptional training of these professionals.

Most of the professionals trained by the MD-PhD program are involved in teaching and research activities, mainly in academic institutions. Among those trained by the University of Pennsylvania MD-PhD program, 84% are academic faculty and only 6% are engaged in private clinical practice (7). Among those trained by the Weill Cornell/Rockefeller/Sloan-Kettering Tri-Institutional MD-PhD program, 90% are involved in research activities, with 72% in academic institutions and only 9% in private practice (8).

Nevertheless, despite such initiatives, the number of medical scientists in the US declined by 22% between 1985 and 1998 (9). Other evidence attests to the decrease in numbers of medical researchers in the US, where they have been called *an endangered species* (10). In 1967, 43% of the NIH research grants were given to MDs or MD-PhDs. That number dropped steadily over the next 20 years, stabilizing at 25% (1). This reduction is significant, but still modest when compared with the loss of medical scientists in the basic disciplines of Brazilian universities, cited for UFRJ in the Introduction.

Such observations raise the question of why the number of medical researchers has declined in the US, if there are opportunities and financial support for their training. The answer involves a multitude of factors: economic reasons; escalating requirements for the construction of a scientific career, which requires many years to obtain full autonomy; bureaucratic and administrative overload, etc. Another factor may be the lack of interest in research among medical students, probably motivated by the social pressures of the advantages that accrue to those who attend patients. However, it is easy to overlook the fact that medical advances depend mainly on scientific research in the experimental areas (1).

The MD-PhD program at the Federal University of Rio de Janeiro

In 1995, in a challenge to the strict academic structure of Brazilian universities, UFRJ started a pioneering MD-PhD program. The goal was to train physicians who would also be successful in the laboratory. In the pilot phase, 6 medical students entered the graduate course in biochemistry during the last year of the medical course. The success of this initiative may be assessed by the academic performance of these medical scientists. Altogether, they have published 233 papers in international scientific journals (Table 1). Of the six students who completed the MD-PhD program in the test phase, two are university professors and two work in research institutes.

In 2000, UFRJ institutionalized a formal MD-PhD program structured in three stages. In the first stage, the medical student in his first or second year is encouraged to join an experimental research laboratory. It is expected that his/her inclination towards medical research will be established in this phase. After two years of supervised experimental work, the student applies for admission to the next phase.

The second phase is a formal engagement with research. The students assume greater responsibility for experimental work, participate regularly in formal research seminars, attend and present papers at national meetings and should mainly begin to publish papers.

Finally, two years before finishing the medical course,

the MD-PhD student of UFRJ must present a seminar and undergo an interview with a committee that evaluates the candidate's aptitude for the third phase of the program, when the applicant should enter a PhD course. Table 1 shows the students who entered and completed the program after its formal establishment. Together with the test-phase students, they have published 294 papers in international journals. It is still too early to evaluate the professional insertion of these MD-PhDs who have emerged from the formal phase of the program, as most of them are still undergoing postdoctoral training or complementing their clinical training.

Unlike what has occurred in the US, in Brazil there are still no national norms for a formal MD-PhD program to guide medical schools that are interested in this venture. Also, as a result of strict institutional structures, it is difficult for a medical scientist to find a position that allows for a dual academic and clinical role, one that encourages both experimental research and contact with patients. In addition to overcoming these limitations, we must move forward in tackling the lack of interest in scientific research on the part of medical students. Apparently, a student's interest in investigating the molecular aspects of diseases is routinely overwhelmed by another one that focuses on patients care, just as has been observed in other countries (1). Understanding these changes in motivation and their possible correlation with students' concepts of science and common sense might help us give new directions to the MD-PhD program.

Concepts of science and common sense among the MD-PhD students of UFRJ

From the seventeenth century on, modern science has differentiated itself from common sense knowledge, becoming progressively a hegemonic body of knowledge. Yet, post-modernity outlines a new paradigm in which all scientific knowledge tends to be based on common sense. Once the first epistemological rupture occurs, from common sense towards scientific knowledge, "the most important epistemological act is a second rupture", which requires a transformation work of both common sense and science (11). It is natural to envision the MD-PhD program within this context of preparing medical students for a double mission: learning to think scientifically, a prerequisite for successful research, and translating these concepts into language their patients can understand, based on their common sense. Thus, the investigation of students' concepts of common sense and science was considered to be relevant for the evaluation of the MD-PhD program of UFRJ.

The exploratory phase of the study was qualitative (12) and used semi-structured interviews to explore the science and common sense concepts of the MD-PhD students (Step 1 in Figure 1). The interviews were recorded, transcribed and subjected to content analysis (13) to identify the most relevant themes for construction of a Science and Common Sense Concept (SCSC) inventory (Step 2 in Figure 1). Each interview began with general and impersonal subjects related to the student's entry into academic life. Then, questions were asked that required reflection on the SCSC concepts. Students were also asked to cite five words "related to science" and another five "related to common sense". Finally, each student was asked to evaluate the MD-PhD program and the ideas under discussion during the interview with any additional comments relevant to issues not covered by the interview.

The investigative phase was more quantitative and used the SCSC inventory subdivided into 22 thematic categories, identified in the exploratory phase. It was clearly possible to associate the thematic content of the students' interviews with concepts of science and common sense mentioned by various philosophers and educators. As a consequence

Table 1. List of students who completed the MD/PhD program of the Federal University of Rio de Janeiro and number of publications in their careers.

Student	Year of PhD completion	Publications in their careers*	Average impact factors of the journals
Test phase			
Castilho RF	1997	89	4.017
Francischetti IMB	1997	81	4.568
Meinicke AR	1997	14	3.462
Maya-Monteiro CM	2000	23	4.411
Reis MM	2001	15	4.654
Louzada PR	2003	11	3.073
Formal phase			
Legora-Machado A	2006	5	3.187
Leite-Junior JHP	2006	6	4.911
Costa MR	2006	10	7.043
Cadete RA	2006	3	3.829
Stauffer F	2006	9	3.240
Nazareth RA	2007	3	4.347
Lachtermacher S	2007	2	1.075
Carvalho AB	2008	8	5.233
Monteiro JP	2009	3	5.758
Gonçalves RG	2010	5	3.557
Pimentel-Coelho PM	2010	5	3.511
Esporcatte BLB	2010	2	1.075
Total		294	

*Data obtained from Pubmed as of August 2011.

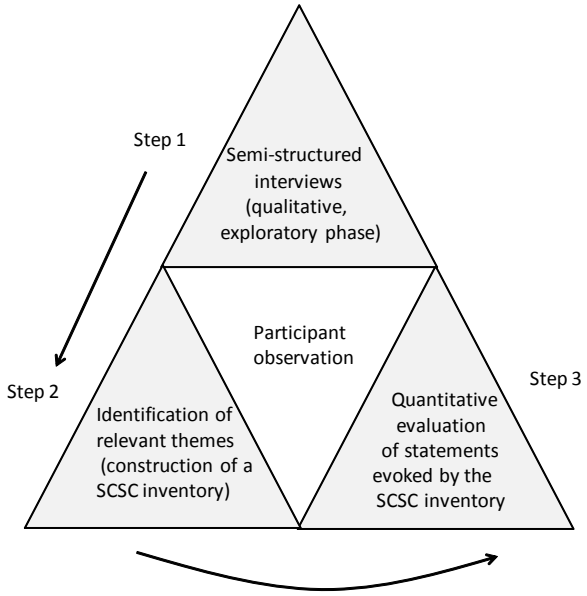

Figure 1. Summary of the qualitative and quantitative triangulation method used to evaluate the students' concepts of science and common sense. *Step 1*, This is an exploratory phase based on semi-structured interviews to explore the concepts of the MD-PhD students. *Step 2*, The interviews were subjected to content analysis to identify the most relevant themes for construction of a Science and Common Sense Concept (SCSC) inventory. *Step 3*, Twenty-two sentences taken from published statements by well-known philosophers and educators talking about science and common sense evoked in the SCSC inventory were scored by the students and physician-scientists using a Likert-scale-based methodology. All three steps of the investigation involved verbal interactions with the observer/interviewer ("participant observation") in order to evaluate the subject's affect on the day of the interview.

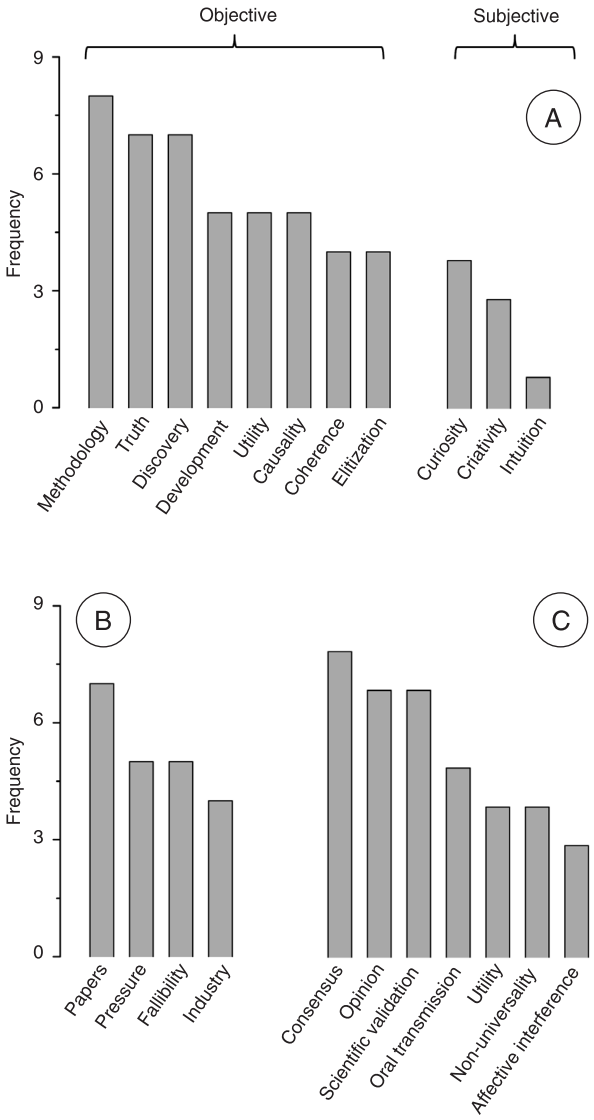

Figure 2. Frequency of the themes mentioned by the MD-PhD students during the semi-structured interviews related to the objective and subjective aspects of scientific thought (*A*), production of scientific knowledge (*B*) or common sense (*C*). The content of the interviews was subdivided into 22 thematic groups using the Science and Common Sense Concept (SCSC) inventory, and compared with published statements about concepts of science and common sense enunciated by well-known philosophers and educators.

of the sampling, the participant observation of the research field permeated the intertwined phases of the research, contributing to the triangulation of the methodological data (14) either in both the construction and validation of the SCSC inventory validation and its more refined analysis.

The frequency of the themes mentioned in the interviews is shown in Figure 2. The subjective aspects were less frequent than the objective ones (Figure 2A). The concern with "methodology", "truth" and "utility" were preponderant, while "intuition", "creativity" and "curiosity" were mentioned less. The comments of the students about scientific productivity showed a great concern regarding publishing and pressure to publish, reflecting the atmosphere in their laboratories and among Brazilian scientists in general (15). Common sense was associated with consensus, and with opinions that were recognized as requiring scientific validation.

There was some ambivalence in the students' opinions about the production of scientific knowledge. Although they tended to associate scientific knowledge with real information (7 of 12 students), some of the same students mentioned that scientists may manipulate data, leading to false information (5 of 12 students).

In a third stage of the quantitative analysis (step 3, Figure 1), MD-PhD students were evaluated by the Likert-scale-based methodology (16,17). Twenty-two sentences taken from published statements by well-known philosophers and educators about science and common sense evoked in the SCSC inventory were scored by the students according to the scale of the instrument, which ranges from -3 (strong

disagreement) to +3 (strong agreement).

Three examples of the statements used are cited. For "methodology" in "science": "The scientific experiment must be set up to investigate a specific hypothesis. Because the scientific method requires you to experiment, then not being able to set up an experiment limits scientific knowledge" (http://www.biology.ie/doc/WEB_SM.pdf). For "intuition" in "science": "My view may be expressed by saying that every discovery contains an 'irrational element', or a 'creative intuition' ...laws... can only be reached by intuition, based upon something like an intellectual love of the objects of experience" (http://www.todayinscri.com/P/Popper_Karl/Popperkarl-Quotations.htm). "Opinion" in "common sense": "…an inherent characteristic of common sense though…is that its tenets are immediate deliverances of experience, not deliberated reflections upon it" (18).

The median and quartile intervals (Q_1 and Q_2) were calculated from the scores, as shown in Figure 3A. The de-

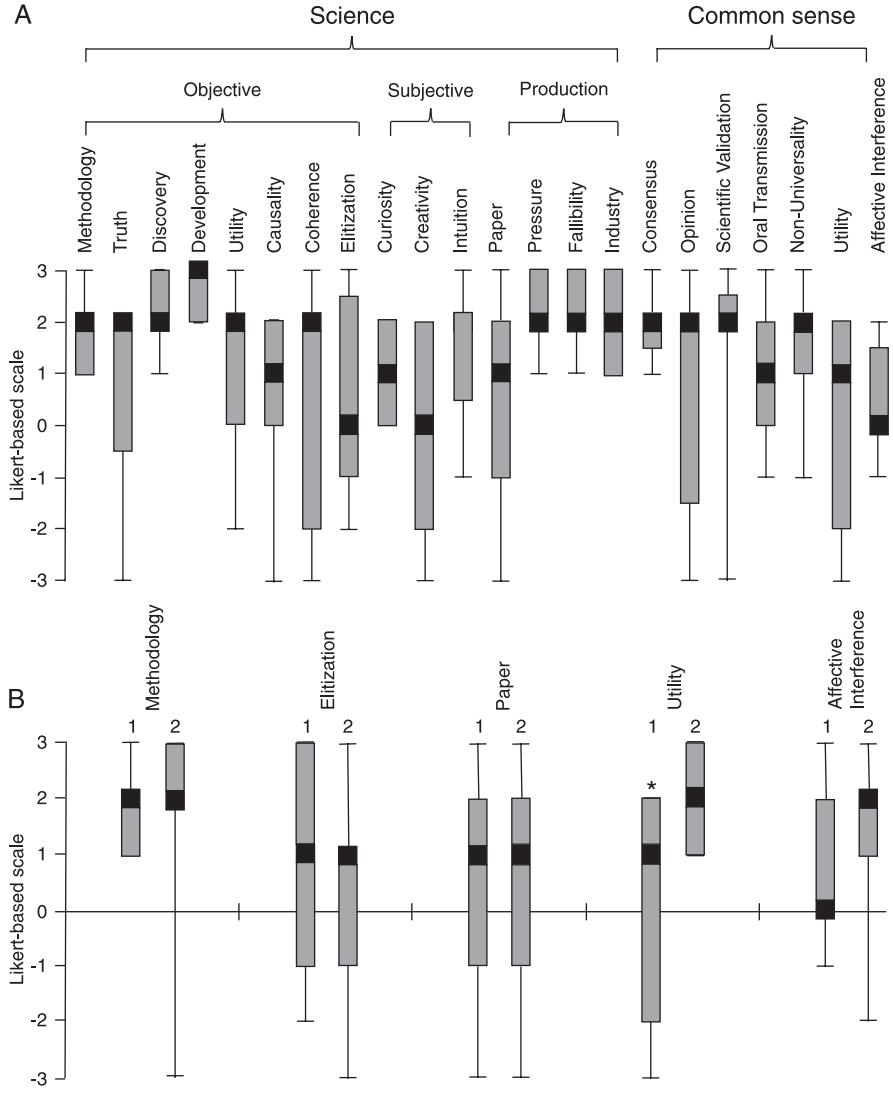

Figure 3. Extent to which MD-PhD students and physician scientists agree with classical concepts of science and common sense. Twenty-two classic statements about science and common sense were scored by 12 students in the MD-PhD program (*Panel A* and 1 in *Panel B*) and 36 physician-scientists (2 in *Panel B*) according to the Likert scale, which ranges from -3 (strongest disagreement) to +3 (strongest agreement). The results are presented as median scores (black), quartile intervals (Q_2 - Q_1, in gray) and maximum/minimum values (lines). *P < 0.05 based on the Mann-Whitney test for comparison between MD-PhD students and physician-scientists. In *Panel B*, the degree of agreement between students and physician-researchers was not significantly different for the 17 concepts not shown in Panel 3B.

gree of agreement with the classical concepts was high, with an average score of +2. Interestingly, the concept that evoked the least agreement was the one concerning "affective interference", or "emotional involvement" in scientific work (0 score). Even with regard to the importance of "intuition" in scientific work, the students showed a high degree of agreement, although only one student mentioned it during the interviews. In the "coherence" and "elitization" items of scientific thought, "opinion" and common sense "utility" showed higher interquartile dispersion (Q_1 - Q_2 = 5; Figure 3A), indicating that MD-PhD students have very divergent opinions on the subject.

In the quantitative phase of the investigation, we also assessed 36 UFRJ medical scientists with regular scientific production, using the same methodology as described for the students. A similarity was observed between the values obtained with the MD-PhD students and those obtained with the medical scientists, as exemplified for "methodology", "elitization" and publication of articles ("papers") in Figure 3B. The only concepts that revealed differences between MD-PhD students and the medical scientists were the ones concerning "affective interference" in science and "utility" or the "usefulness of science", with a significant difference only for the latter aspect.

Conclusions

The MD-PhD program of UFRJ is a successful initiative that allows the training of physicians for experimental research. Indeed, it is noteworthy that it was possible to set up this course despite the country's strict legislation and the resistance of more conservative academic groups. Initial results indicate that the program has been able to meet its objectives with regard to scientific productivity with international visibility and with regard to its graduates' scientific career. Over this same period, Brazil enjoyed a significant increase in scientific productivity. The current challenge is to raise the quality and international impact of Brazilian science. In light of the excellent qualifications of these professionals, engaging physicians in experimental research must become one of the strategies to reach that goal.

More specifically, our study outlines a methodology for evaluating concepts of science and common sense among the students who are part of the MD-PhD program of UFRJ. Qualitative and quantitative triangulation methodology as well as participant observation allowed the synthesis of data collected from different angles. This strategy is intended to overcome the limited heuristic value of data derived from the exclusive use of only one of the methodologies.

The concept of science held by UFRJ's MD/PhD students is far more linked to scientific methodology than to any other science descriptors. Clearly, students give higher priority to more objective characteristics rather than to the subjective ones to describe what science is. The students' interviews criticize the interference from non-scientific concerns. They recognize, for example, that vanity and personal economic interests undermine science as a field and affect the production of scientific knowledge. Students only recognize the value of intuition in science when evoked by the instrument, but do not mention it spontaneously. This suggests a failure to incorporate conscious intuition as part of scientific practice. Finally, the students show the same difficulty that pervades the academic environment when it comes to surmounting a second epistemological hurdle, that is, to consider common sense as another valid approach to solving scientific problems. Overcoming this difficulty at an early stage in the students' training may be an important step toward generating physicians interested in experimental research.

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