THE ROLE PLAYED BY CONTRIBUTORY SCIENTIFIC DISCIPLINES IN TECHNICAL PROGRAMS: A DIDACTIC QUESTION

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As part of a training activity in didactics, I was led to establish connections between a professional situation and an instructional situation. This reflection led me to ask myself how I could make chemistry, the discipline I teach, more meaningful for students enrolled in respiratory therapy, the program in which I teach chemistry.

The first thing to know more about was the occupation of respiratory therapist. I needed to explore the profession. In doing so, I could contextualize my teaching. In other words, and this is the subject of my article, I explored the various ways in which my discipline could serve respiratory therapy without sacrificing my integrity as a chemist.

THE ROLE OF CHEMISTRY IN THE RESPIRATORY THERAPY PROGRAM

I teach chemistry, a discipline that is uncompromising. However, I am also a teacher in the Respiratory therapy program at Collège de Rosemont.

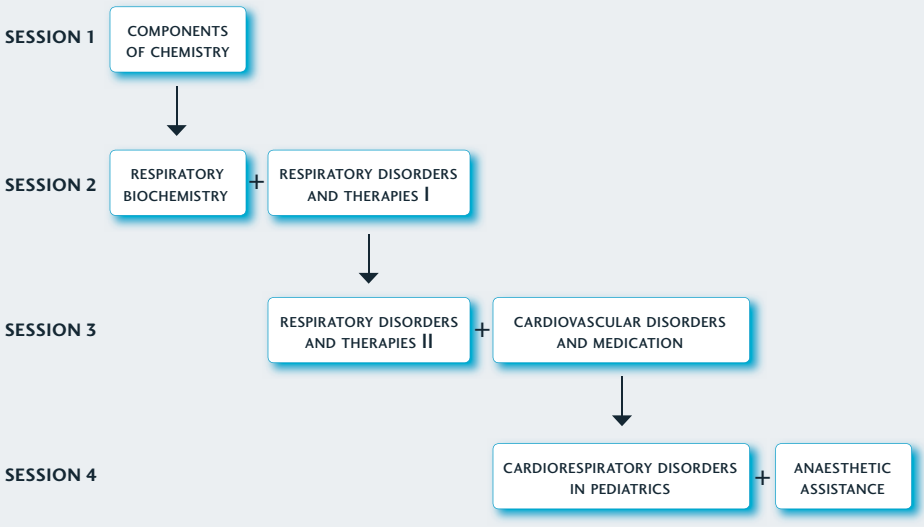
In this program, the students take two chemistry courses: general chemistry and chemistry of solutions in the first session and a course in respiratory chemistry in the second. Students receive a total of 150 hours of instruction in the first year of their program.

Surprisingly, the ministerial specifications for the program do not stipulate teaching any competency associated to chemistry. In other words, even if all respiratory therapy programs in Québec include one or two courses in chemistry, there is no real integration of chemistry into respiratory therapy training. At Collège de Rosemont, the respiratory therapy program committee initially resolved this difficulty by linking the chemistry courses to competency 002G in the ministerial specifications. The definition of this competency is "*to relate drug preparation to clinical situations of respiratory therapy and anaesthesia*". So the only thing connecting chemistry to this competency are two little words "drug preparation" which, in practice, amount to nothing more than a few elementary rules of dilution. This seems very little considering that we are talking about a scientific discipline essential to the practice of this profession, as I will demonstrate presently.

As a contributory discipline in the respiratory therapy program, chemistry finds itself in a strange situation: Even though it represents 150 hours of training, no specific competency relative to this discipline is acquired at the end of the course. All things considered, chemistry is one contributor among many in the achievement of a comprehensive competency that can, subsequently, be very difficult to administer. Figure 1 illustrates the sequence of courses that leads to the achievement of this competency through four4 sessions.

Figure 1: THE DEVELOPMENT OF COMPETENCY 002G

(To relate drug preparation to clinical cases of respiratory therapy and anaesthesia)



Between the time a student takes his first chemistry course and the moment he achieves the competency associated with the chemistry course, two years will have elapsed. This represents an enormous amount of time between the actual chemistry training and the use of this knowledge by the student in a real life context



A CONTRIBUTORY DISCIPLINE IS NOT A PROFESSIONAL PRACTICE. SO, WHAT IS ITS PURPOSE?

Let's tackle the problem of the gap between my educational background and the program in which I teach. Five years ago, when I started teaching in the program, I was faced with the fact that as a chemist, I knew very little about respiratory therapy. More precisely, almost everything relating to the practice of this profession was new to me. This gap created a didactic problem that was at once theoretical and practical: The students I am teaching will not become chemists but respiratory therapists. However, since they receive 150 hours of training in chemistry, their professional practice must inevitably involve many concepts connected to this science. Problem was, I did not know precisely which concepts and especially, how they would be used by professionals in this field.

I turned to the *Ordre professionnel des inhalothérapeutes du Québec* (OPIQ) – Québec order of professional respiratory therapists, and their publication *Compétences relatives à l'entrée dans la pratique* – "Competencies relative to entry into professional practice" – to try and get information relative to the chemistry concepts that respiratory therapists must master. The list of concepts was impressive: the preparation of solutions by dilution; the solubility of gases; theuse of buffer solutions; the knowledge of key principles governing the physicochemical behaviour of molecules; the physicochemical behaviour of organic functions connected to biochemistry; the reactivity and general metabolism of biological molecules; the movement of gases in the organism; the knowledge and analysis of the principal causes of acid-base disorders. Any chemist who reads the above lines, will identify with these concepts since they are major components of chemistry and biochemistry.

In practicing respiratory therapy, a professional uses a significant amount of knowledge that can be classified as chemical or biochemical. However the chemistry concepts are always used within a clinical context and never in isolation. Take for example a drug used to treat asthma. It can be studied from a structural point of view (chemistry), from the perspective of its use, its dosage (anatomy, physiology, pathology and pharmacology), or its metabolism (biochemistry and pharmacology), etc. The bottom line is that the practice of respiratory therapist is multidisciplinary and, from this perspective, chemistry and biochemistry are unquestionably contributory disciplines.

The challenge therefore, is to get students to understand the connection between the professional practice to which they are destined and the chemistry courses they are taking. Or, to quote Claude Raisky (1996): "The professional never reasons in disciplinary terms: He must initially resolve problems. […] disciplines and, in particular, scientific disciplines […] must show in a tangible manner that they play a role in the construction of human activity." In other words, training in chemistry (or in any other contributory discipline) must have real and concrete meaning in students'minds.

One can reformulate this challenge in current didactic terminology: How does the teacher of a scientific discipline transfer and transform his knowledge into knowledge that will be thoroughly grasped by the student i.e. be meaningful and useful to him in his future professional practice?

WAYS TO ACHIEVE A DIDACTIC TRANSFER THAT IS MEANINGFUL FOR STUDENTS

In a text published in 1998, Philippe Perrenoud states: "To organize education around competencies, is to require accountability from each teacher and each discipline […], to demand that they reflect and clarify their specific contribution to the development of the competencies targeted as final goals. Schools are filled with teachers who continuously affirm the importance of their discipline and their teaching, yet do nothing to show how they are resources for eventual professional action, and who make no attempt to structure their contributions and teaching to an eventual transfer and integration into professional practice."

Some could consider this as a criticism of the attitude projected by contributory disciplines which are part of a technical training program. I prefer to see it as an invitation to demonstrate the relevancy of the content presented to students.

How can we rise to such a challenge? In a typical case like the one under analysis here, I began to familiarize myself with respiratory therapy practices. I asked my colleagues in respiratory therapy to teach me about their work environment, to show me what they do on a daily basis and especially, to explain to me how and why they perform the actions they do.

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To further understand the practice, I spent one full day with a colleague in a hospital. We visited the intensive care

unit, the operating theatre, the pulmonary evaluation unit and then we made the rounds of several floors. Whenever possible, we took the time to discuss various points with the respiratory therapists on duty so I could better understand the nature of their work.

All in all, this first visit allowed me to get acquainted with the profession that my students will practice. At the same time, I did notice that chemistry and biochemistry are omnipresent in this profession, since one of the first actions performed by a respiratory therapist when treating a patient is to look at the clinical data on file (blood pH, P_{CO2} and in particular the concentration of bicarbonate ions), thus to analyze the situation based on the chemical data.

This work also motivated me to make sure that my way of encouraging students to approach chemistry would lead them to see its concrete applications in respiratory therapy.

This experience begged the following question: What is the specific use of chemistry in respiratory therapy?

To answer, I prepared an integrating diagram, a graphic model that begins with chemistry, and in which every chemistry concept, without exception, leads to an application in respiratory therapy (this figure, quite complex, is not presented in this article).

So, in this figure, the unbroken lines connect chemistry concepts to each other. They lead to central concepts in chemistry. The dotted lines connect the practice of respiratory therapy to chemistry concepts. Thus, the diagram shows that chemistry is the study of matter, that this matter is what makes up solutions among others, and that, when describing a solution, it is necessary to take into account the solubility of substances that make up the solution. The solubility of gases described by Henry's Law, allows for the calculation of concentrations of blood gases (oxygen and carbon dioxide), thanks to their respective partial pressure. These gases are bound to the haemoglobin and this bond constitutes one of two means by which gases travel.

This exercise made it possible to sort through and make a correct selection of notions, concepts and methods that should be favoured in chemistry and biochemistry courses within the respiratory therapy program. Any chemist reading this will undoubtedly notice that the concepts of electronic configuration or hybridization of atomic orbitals for instance, are not addressed in these courses. In my opinion, this omission is due to the fact that the model of valence-shell electron-pair repulsion (VSEPR) allows the students to construct a representation of molecules and especially of their polarity which, although not complete or up to date, is nonetheless accurate. Moreover, this way of visualizing molecules does not prevent students from progressing with the learning they must acquire to be in a position to interpret a clinical case based on physicochemical and biochemical parameters.

This work also motivated me to make sure that my way of encouraging students to approach chemistry would lead them to see its concrete applications in respiratory therapy. It would not be possible for me to continue on this path without the collaboration of my colleagues in the main discipline, i.e. respiratory therapy. They immediately acknowledged my intentions and never hesitated to open their professional environments and give me some of their time, whether it was during a visit to an intensive care unit in neonatology (visit supported by a thorough explanation of the particularities of this clientele), observation in the operating theatre following surgery with invasive monitoring, documentary research on drugs, and more.

These colleagues were always available to answer my constant questions such as "Can you interpret this clinical data for me out loud?"; "Can you explain this pathology and why this drug acts as it does?"; "Does this way of introducing the concept have meaning for you?" and many others.

CONCLUSION

To conclude: For teachers of a contributory discipline to choose the content correctly and for subsequent learning to make complete sense to the students, it is necessary to explore the professional universe in which this content will be put into action and to commit to using all the means available to see to it that this content is contextualized and explicitly connected to the professional practice in question. On the other hand, it is necessary for those whose discipline is considered contributory to the technique, to assist in bringing this long and demanding work to fruition. Without this openness and mutual collaboration, the disciplines are very likely to remain scattered groups of knowledge with no perceptible utility for students, which would be a real pity.

In closing, I hope that this article helps my colleagues see the importance of this mutual sharing.



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