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Integrative approach in biochemistry practice: from laboratory to clinic

Jéssica Silva Peixoto Bem[1]
0000-0001-9456-6918
Jennifer Mayumi Hashimoto[1]
0000-0003-0373-2242
Renata Sant'Anna Consiglieri[1]
0000-0001-9971-4836
Carem Gledes Vargas Rechia[2]
0000-0002-9156-376X
Carolina Patrícia Aires[2]
0000-0003-0632-5992

[1]Faculdade de Odontologia de Ribeirão Preto, Universidade de São Paulo (USP), Ribeirão Preto, São Paulo, Brasil

[2]Faculdade de Ciências Farmacêuticas de Ribeirão Preto, Universidade de São Paulo (USP), Ribeirão Preto, São Paulo, Brasil

Correspondence:
Carolina Patrícia Aires
E-mail: airescp@fcfrp.usp.br

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Abstract The objective was to report the experience of students and professors regarding the application of active methodology tools aimed at integrating Biochemistry themes with those of the disciplines from the clinical-professional axis. Initially, subgroups for the practical class were divided into work teams. The students received a protocol containing objectives, general principles and procedures the week before the practical class. On the days of the "Preparation of Solutions" and "Buffering Capacity" classes, a scientific article related to Dentistry was delivered for group reading and discussion. As a practical activity, the teams received a challenge related to the article, which would require application of the class objectives. This experience demonstrated that the active methodology can work as a facilitator for a contextualized and integrated approach to Biochemistry, reflecting in greater engagement and student performance, in addition to contributing to meaningful learning.
Descriptors: Biochemistry. Education, Dental. Teaching.

Enfoque integrador en la práctica de la bioquímica: del laboratorio a la clínica
Resumen El objetivo fue relatar la experiencia de estudiantes y profesores en cuanto a la aplicación de herramientas metodológicas activas para la integración de los temas de Bioquímica con los de las disciplinas del eje clínico-profesional. Inicialmente, las subclases de la clase práctica se dividían en equipos de trabajo. Los estudiantes recibieron un protocolo con objetivos, principios generales y procedimientos en la semana anterior a la clase práctica. En los días de las clases de "Preparación de Soluciones" y "Capacidad Amortiguadora", se entregó un artículo científico relacionado con la Odontología para lectura y discusión en grupo. Como actividad práctica, los equipos recibieron un reto relacionado con el artículo y que requería la aplicación de los objetivos de clase. Esta experiencia demostró que la metodología activa puede funcionar como facilitadora de un abordaje contextualizado e integrado de la Bioquímica, reflejándose en un mayor compromiso y desempeño de los estudiantes, además de contribuir al aprendizaje significativo.
Descriptores: Bioquímica. Educación en Odontología. Enseñanza.

Abordagem integrativa na prática de bioquímica: do laboratório à clínica
Resumo Objetivou-se relatar a experiência de discentes e docentes diante da aplicação de ferramentas de metodologia ativa para a integração dos temas de Bioquímica com os das disciplinas do eixo clínico-profissional. Inicialmente, as subturmas da aula prática foram divididas em equipes de trabalho. Os alunos receberam um protocolo contendo objetivos, princípios gerais e procedimentos na semana anterior à aula prática. Nos dias das aulas de "Preparo de Soluções" e "Capacidade Tamponante", um artigo científico relativo à Odontologia foi entregue para leitura e discussão em grupo. Como atividade prática, as equipes recebiam um desafio relacionado ao artigo e que exigiria aplicação dos objetivos de aula. Esta experiência demonstrou que a metodologia ativa pode funcionar como facilitadora para uma abordagem contextualizada e integrada da Bioquímica, refletindo em maior engajamento e rendimento dos alunos, além de contribuir para um aprendizado significativo.
Descritores: Bioquímica. Educação em Odontologia. Ensino.

INTRODUCTION

In undergraduate Dentistry courses, theoretical Biochemistry contents are complemented by laboratory activities, in which the student has the opportunity to experience and discover the practical value of acquired knowledge. However, despite the importance of Biochemistry for health professionals, a failure to contextualize it with future clinical activities can cause the student to lose motivation and, consequently, make learning difficult[1].

The National Curriculum Guidelines [*Diretrizes Curriculares Nacionais*] for undergraduate Dentistry courses[2] place the Biochemistry discipline on the axis of the Biological and Health Sciences, including, "in an integrated manner, the theoretical and practical contents of a biochemical, molecular, morphological, cellular and tissue basis referring to normal and altered processes, as well as the structure and function of tissues, organs, systems and apparatuses, with application in situations arising from the health-disease process and in the development of dental care practice for comprehensive health care". In this sense, basic Biochemistry aims to study the structure, function and metabolism of macromolecules, such as carbohydrates and proteins, which are fundamental to understanding different physiological and pathological processes, such as those related to caries[3].

Nonetheless, despite its relevance, this content is considered difficult for students to understand. Biochemistry is generally defined by students as a set of chemical structures and reactions disintegrated from professional life[1]. In addition, professors also report difficulties in demystifying Biochemistry and making it attractive[4]. The fact that these contents are worked on in the initial periods of the course can contribute to the difficulty in abstracting and understanding its essential concepts[5]. Thus, practical activities can be an opportunity to consolidate the themes presented in theory and correlate them with clinical practice.

In this sense, tools based on active methodologies are of great value, as they favor the student's autonomy while arousing curiosity and stimulating decision-making at the individual and collective levels[6,7].

Although forms of operationalizing these methodologies, such as Problem-Based Learning and Team-Based Learning, serve as critical-theoretical bases for their application, active teaching-learning methodologies are diverse and include tools such as seminars, work in small groups, socialization, round tables, plenary sessions, dialogued expositions, thematic debates, workshops, commented reading, ludic-pedagogical dynamics, portfolio and oral evaluation, etc[8,9].

Thus, the objective was to report the experience of students and professors concerning the application of active-methodology tools for the integration of knowledge from Biochemistry with that from the professional axis.

EXPERIENCE REPORT

The discipline was offered to students attending the first period at the Ribeirão Preto School of Dentistry [*Faculdade de Odontologia de Ribeirão Preto*] (FORP/USP), with 30 hours for theoretical activities, and 60 hours for practical classes in divided groups. Although some of these classes are specifically aimed at the study of dental structure and bacterial metabolism, most of the content was not contextualized with Dentistry-related themes, with emphasis on the "Preparation of Solutions" and "Buffering Capacity" contents, essential for one's work as a dental surgeon, given its applicability to medication dosage, provision of molding materials, and understanding of key Cariology concepts.

The "Preparation of Solutions" class aims to enable students to perform simple calculations in order to prepare solutions, based on the concepts of magnitudes, direct and serial dilution, as well as identification and handling of glassware. The "Buffering Capacity" class, in its turn, intends to introduce the concept and functioning of buffer solutions, as well as enable the student to determine the buffering capacity of these solutions (pH and pKa). Such concepts are fundamental to understanding the behavior of organic and inorganic solutions as biological fluids and industrial processes.

Usually, the students receive a protocol containing objectives, general principles and procedures the week before the practical activity. For the practical classes, a group of 90 students was divided into two subgroups of 45 students and, in each of them, the students were gathered into teams of 5 people. They worked in the same team throughout the semester, except during the knowledge assessment, which was applied individually.

It is important to point out that group work is not just a meeting of people with a common goal. When well planned, it allows for developing intrapersonal and interpersonal intelligence based on emotional self-knowledge, self-motivation and recognition of the emotions of others[10,11]. Thus, from the discussions, the students would be encouraged to listen to one other and change as to their way of thinking in order to solve problems and reach the established objective.

Therefore, for an effective group practice, the students need clearly established goals and steps. Moreover, the professor must be attentive and available to supervise the processes developed by the groups in the classroom[12].

Traditionally, at the beginning of each practice, the professor would provide a brief explanation, and questions about the protocol and concepts would be answered, which would be followed by a discussion of the flowchart of the experiments group by group. This routine was maintained, with the addition of a contextualization of concepts from the reading of published clinical cases and research articles, so that the student could associate the findings of these publications with biochemical concepts.

In this way, bearing in mind the Freirean concept that “you only learn what is meaningful”[13], this initiative was based on the adult student’s need to identify the applicability of the themes with which they are presented and, consequently, recognize their relevance, assigning them meaning[14,15]. Therefore, the practices were designed with the aim of presenting potentially meaningful material to the students, while seeking to resolve their complaints about the difficulty of the themes and how they were disconnected from their future professional activities.

To prepare the didactic material, a bibliographic survey was carried out, with the selection of a clinical case report[16] for the “Preparation of Solutions” class and a research article[17] for the “Buffering Capacity” class. After reading, each group received a questionnaire with guiding questions (Figure 1) in order to stimulate a discussion on the topic in question. For the practical part, the groups were given a challenge related to the article, which required application of the class objectives.

Thus, for the “Preparation of Solutions” practice, the scientific article dealt with the case report of an elderly woman affected by Sjögren’s Syndrome, whose main symptom is xerostomia due to a deficiency in saliva production. The proposed challenge was to prepare 100 mL of artificial saliva[20], which would be prescribed to alleviate the patient’s symptoms. Each group received a list of the chemical reagents needed to prepare the solution (Figure 2). However, such reagents had their concentrations changed and presented in other magnitudes and units. Therefore, the student was required to convert magnitudes and calculate dilutions so that it was possible to prepare the solution.

For the “Buffering Capacity” class, the scientific article investigated the cariogenic effect of different substances (cola-type soft drinks, human and bovine milk, honey and sucrose) frequently ingested by children and potentially associated with early childhood caries. While reading the article, the students were exposed to the information that the adverse effects of sugar were pronounced when there was a restriction of saliva access to the tooth surface, such as when using bottle nipples, limiting the buffering capacity of saliva. From that, the importance of this property in saliva was emphasized, since it is key to understanding the mechanism of demineralization and remineralization of dental structures and how its deregulation aggravates pathologies, such as caries and dental erosion.

After group discussion, images of early childhood cavity lesions, popularly known as “nursing bottle caries”, were projected for illustration and comments on the effects of buffer deregulation in biological fluids. In addition, a graph taken from the suggested textbook[16] was displayed for discussion around the pH drops that occurred in the mouth after each meal.

The practical challenge consisted of preparing 50 mL of 0.4 mol/L phosphate buffer solution, pH = 7.4, subjecting it to a sequence of dilution and acid test, so that, at the end of each reaction performed, the student was able to interpret the results found. The support sheet is illustrated in Figure 3.

Class	Guiding Question
Preparation of Solutions	1. Where is saliva produced? How much do we produce, on average, in a day?
	2. What is the function of saliva?
	3. What is the composition of saliva?
	4. What disease does this patient have?
	5. As future dental surgeons: what will be your importance for the diagnosis of this disease?
	6. What would be a treatment suggestion for this patient?
	7. Does artificial saliva have the same composition as natural saliva?
Buffering Capacity	1. What would be the mechanical effect of the bottle nipple, to which the authors refer?
	2. What is the physiological pH of the oral cavity?
	3. What is buffering capacity of saliva?

Figure 1. Questionnaire with guiding questions for group discussion.

Chemical Reagent	Concentration	Amount in g/100 mL or mL/100 mL
Potassium diacid phosphate (KH_2PO_4 MM= 136 g/mol)	326 mg/L	0.0326 g
Potassium dibasic phosphate (K_2HPO_4 MM= 174 g/mol)	0.00460964408 mol/L	0.0802 g
Potassium chloride (KCl MM= 74.5 g/mol)	620 µg/mL	0.0620 g
Sodium chloride (NaCl MM= 58.5 g/mol)	0.09%	0.0865 g
Magnesium chloride (6 H_2O) ($MgCl_2$ MM= 202 g/mol)	0.125 mg/mL	0.0125 g
Calcium chloride (2 H_2O) ($CaCl_2$ MM= 147 g/mol)	72 ppm	0.0072 g
Sodium fluoride (NaF MM= 42 g/mol)	4.25 ppm	0.0004 g
Sorbitol 70%	427 g/10 L	4.27g
Flavoring	Minimum amount to produce a pleasant taste, odor and appearance.	
Preservative solution containing Nipagin and Nipasol	10^4 µL/L	1 mL
Thickener	500 mg/ L	0.5g
Water qsp	Top up to 100 mL	

Figure 2. Components necessary to prepare 100 mL of artificial saliva[20]. In the column described as 'amount in g/100 mL or mL/100 mL', the student should fill in, based on the calculations performed, the correct amount to prepare artificial saliva.

0.4 mol/L phosphate buffer solution, pH = 7.4	
Components	**H_3PO_4 pKa values**
Na_2HPO_4 MM: 141.96	pKa_1= 2.12
$NaH_2PO_4.H_2O$ MM: 138.0	pKa_2= 6.9
	pKa_3= 12.67
Additional information	**Equations**
$10^{0.05}$ = 1.1220	$pH = pka + log \frac{[\text{proton acceptor}]}{[\text{proton donor}]}$
$0,5^{10}$= 0.00097	
$10^{0.5}$ = 3.16228	[buffer] = [proton acceptor] + [proton donor] or
10^{5}= 100000	[buffer] = [conjugate acid] + [conjugate base]

Figure 3. Information contained in the support sheet for preparation, dilution and acid test of buffer solution.

During the classes, it was noticed that the change in the way of presenting the contents was reflected in the students' engagement, who were more participative. Such interest and motivation had consequences in the improvement of the group's performance, observed quantitatively in the results of the evaluations.

Because this is a curricular component taught to first-year students, it is recognizable that there is a need to facilitate their transition between dependent adolescents – oftentimes coming from an education based on arbitrary, non-reflective or meaningful memorization – to self-directed adult learners. Becoming a university student encompasses maturing as a person and as a student who is responsible for their own learning process. In this way, knowledge construction is a consequence of this autonomy.

Thus, understanding the changes arising from maturation is essential to help the learning process of these new adults. According to Knowles's andragogical principles, as people mature, they become responsible for their decisions and interests, while accumulating experiences that will subsidize their future learning. Generally, such interests are directed towards obtaining tools and developing skills that enhance their social and professional development, reducing their inclination to topics that do not prove to be useful[17].

However, the need to assimilate applicable knowledge is not satisfied just by knowing the reason for learning something. The full satisfaction of this need will result from knowing how learning will be conducted, what will be offered, and why that would be important[13]. Awareness of where they are (what they already know and skills they already have) and where they want to go is a motivating factor for engagement.

FINAL CONSIDERATIONS

The observations provided by these experiences show that the active-methodology tools were useful for a contextualized and integrated approach to Biochemistry. The connection with the Dentistry students' possible interests contributed to motivation and participation in classes, which was reflected not only in improved performance in assessments, but also in the social component and problem solving, symbolizing their maturation as learners.

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