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Proteins: proposing the construction of a Didactical Multimedia Material to get Teachers and Interdisciplinarity Together

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***Abstract*—Interdisciplinarity may help teachers on preventing the excessive fragmentation of the scholar curriculum also approximating it from the students' life. In order to create these interdisciplinary moments, teachers need educational materials to support their professional activity. On this context, there is an urgent need for interdisciplinary materials able to help this interdisciplinary process. This article focuses on the development and implementation of an interdisciplinary multimedia material about the theme Proteins. The material was developed using an interdisciplinary way involving high school teachers of biology and chemistry. Its main purpose is to offer interdisciplinary moments not only for the students but also for the teachers involved**.

***Keywords* — biology, chemistry, interdisciplinary, multimedia, didactical material.**

I. INTRODUCTION

Elementary and high schools, whether public or private, have the current knowledge generally organized in disciplines. In order to teach, the contents are classified and organized in a independent way, separated one from another, without a clear relationship among them [1,2].

According to the literature, this scholar organization creates a very fragmented curriculum detached from the students context. Year after year the values of the social and academic societies are repeated without concerning about the fully understanding of these concepts by the scholar public [1]. Since knowledge is divided into non-related topics, it is difficult to them to comprehend the multiplicity of issues that involves the real world.

In these last years, some studies pointed the need of knowledge that also represent and contextualize the life outside the classroom, considering and reflecting the personal experiences of the students, preparing them for an independent life [3]. Therefore it is important to create a school that teaches not only piece by piece but also the ideas and the concepts as a whole, using problems and situations to contextualize them [4]. From this point of view, interdisciplinarity emerges as an appropriate method to show the complexity of issues in a daily basis, creating situations and opportunities for the students to gain autonomy on their thinking and on acting based on proper and fully knowledge [2].

Some authors discuss about interdisciplinary methodologies and on how to use them in practical terms at school. Currently it is not possible to determine definitively which one is best or more efficient compared to others. The choice still depends on the targeted public and on the context, subjects and perspectives that the teacher wants to approach/achieve [5].

Among these methods is the one described by Batista & Salvi 2006, which considers as essential the insertion of interdisciplinary teaching moments. The main purpose is to keep the disciplinary structure of the curriculum but with the insertion of interdisciplinary projects with specific pedagogical objectives. This approach should articulate both interdisciplinary and disciplinary knowledge in a coherent and contextualized way [6]. This method is of low complexity as it allows the integration of disciplines in a short time without significantly changing pre-settled scholar schedules and curricula.

Currently, our society is at the "Digital Age" where the computer and other technological instruments seem to be necessary in order to offer good and quality education. In addition, the interaction with the students reality has been noticed as important by the teachers. Therefore these professionals should be prepared to adopt computers in their teaching practices in a current manner. According to [7], despite computer technologies are constantly present in everybody lives (*e.g.* banks and supermarkets), they still did not promoted a significant change on teachers and their teaching methods in most regular schools.

Proteins is one of the most common themes in many

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biological textbooks. This theme is clearly multidisciplinary (Biology, Physics and Chemistry) but also involves interdisciplinary topics such as amino acids, peptide bond, structure and interactions, which allow the simultaneous approach of biological and chemical aspects (*e.g.* enzymatic function versus reactions). Despite that, most schools do not organize or address this theme simultaneously in Biology and Chemistry disciplines.

In this work, our purpose is to produce an interdisciplinary multimedia material about *Proteins* together with biology and chemistry teachers in order to create interdisciplinary moments between these two disciplines at Elementary and High School. Herein we tested the material with high school students to evaluate the efficiency of the material for teaching the theme in an interdisciplinary way.

II. Methods

In order to select the topics about *Proteins* for developing the new multimedia material we first invited five teachers from the same school (2 of Biology and 3 of Chemistry) to analyze 3 high school books from biology and chemistry referred by Brazilian National Textbook Program (PNLEM). The analysis of these textbooks generated three sections that are approached in the material: *i*) Systems and Vital Proteins, *ii*) Origin of Life and Proteins, and *iii*) Proteins: form and function.

In order to approach these sections, we built a database of information and pictures together with 3 of these 5teachers, one of Biology and two of Chemistry. Finally we used the openoffice.orgImpress program version 3.3 to prepare the final prototype of this material to be used by both disciplines simultaneously at school.

III. Results and Discussion

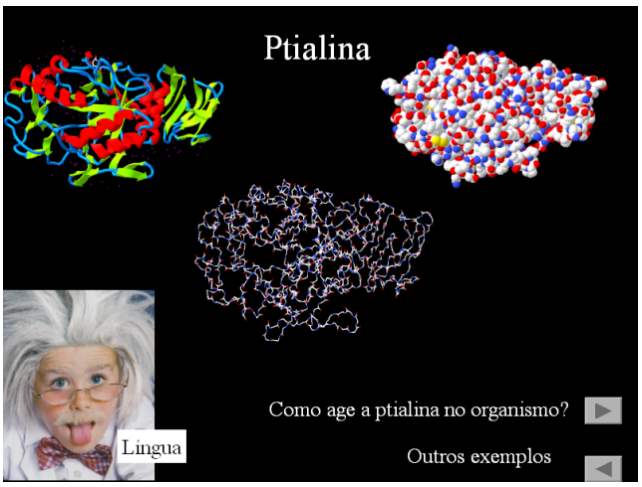
Getting Teachers Together by Constructing the Interdisciplinary Material

According to the literature the construction of didactical materials by teachers really includes them in the implementation of the interdisciplinary practices [8]. [2] suggest that "*reorganization should be produced by the educators themselves and not by the outside*" Therefore, we invited five teachers (two of Biology and 3 of Chemistry) for constructing the material following the Brazilian National Curriculum [10] that uses an interdisciplinary speech about teaching biology: "*Throughout high school, to ensure understanding of the whole…each organism is the result of interactions between organs, apparatuses and systems, in particular, are formed by a number of interacting cells. A deeper level, each cell is configured by the interactions between its organelles, which also have their individual characteristics, and the interactions between the cell and the other.*" as well as for teaching chemistry, " *chemistry teaching should allow the construction of a world view more articulate and less fragmented, contributing to the individual to see how participate in a changing world.*"

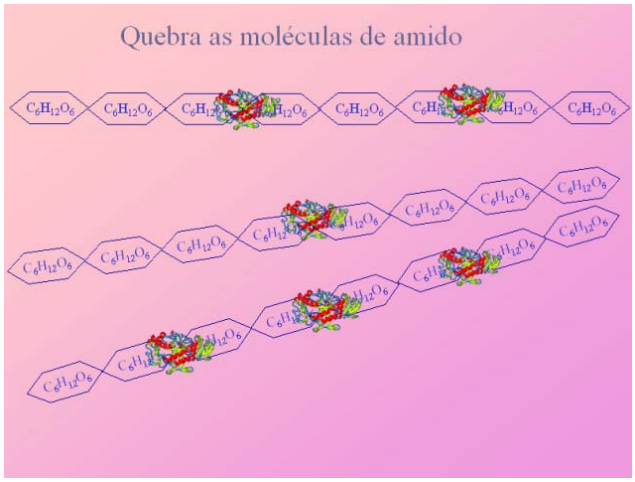
The construction of the interdisciplinary multimedia material with the invited teachers was initiated by selecting some relevant topics about *Proteins* in Biology and Chemistry didactical books. Then, we created the figures and planned 63 slides that make up the whole multimedia material. This didactical tool can be used in any computer that uses open (*e.g.* Oppenoffice3.3.) or private (*e.g.* Microsoft office) systems. It has three sections that illustrate the major proteins topics approached in this material.

A. Systems and Vital Proteins

For approaching this topic, we created 17 slides that address some of the most common proteins present in the human body, including their functioning. Among the proteins selected are included ptyalin (salivary amylase), insulin, pepsin, trypsin and hemoglobin. This first moment is used for presentation of the subject and as motivation that reveals the proximity of the proteins from humans (Fig. 1).



(a)

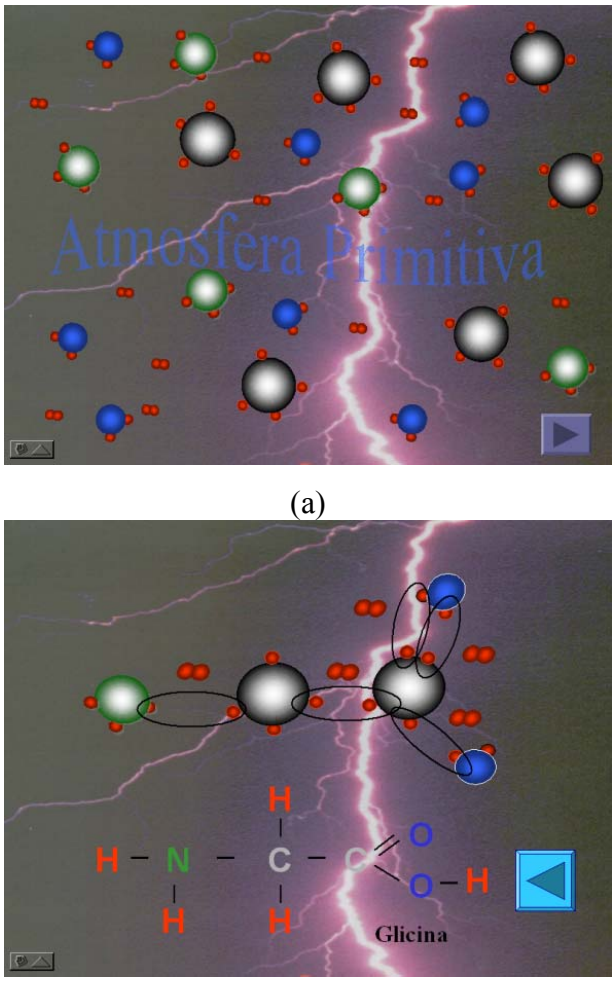


(b)

Fig. 1. Screens of the multimedia material showing part of the section *Systems and Vital Proteins*. The structure of the enzyme (ptyalin) (a) and its function (b), which is animated in the material, allows both biological and chemical approaches.

B. Origin of Life and Proteins

In this topic we created 12 slides that discuss the process of the *Origin of Life* through Oparin and Haldane theory. The proposal about the beginning of life on Earth with the formation of amino acids from simple molecules that made up the early atmosphere (water, ammonia, methane and hydrogen) is explored. In these slides we approached the chemical elements that constitute these simple substances (Fig. 2).



(a)

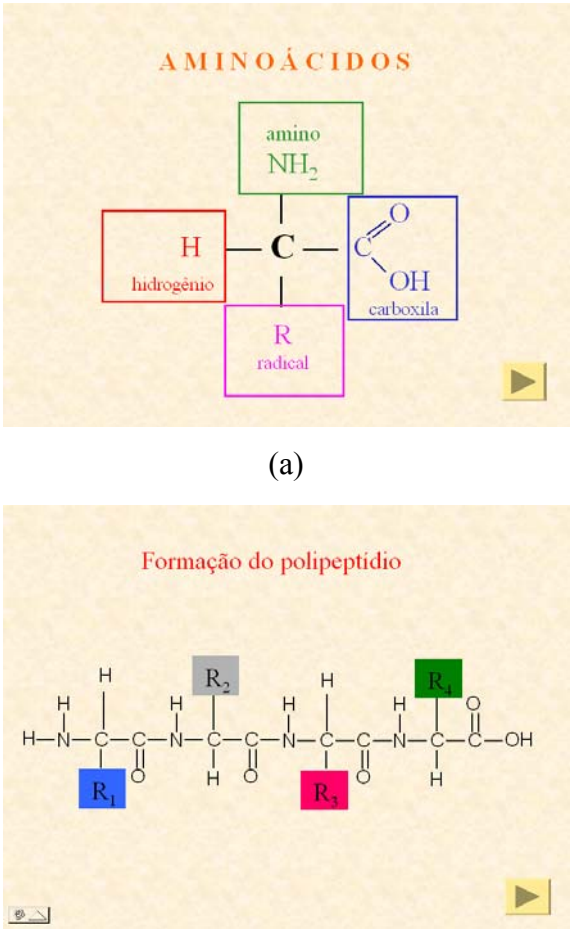
(b)

Fig. 2. Screens of the multimedia material showing part of the section *Origin of Life and Proteins.* The gases that formed the early atmosphere (a) and formation of the first amino acid (b) are shown.

C. Proteins: form and function

In this topic, 24 slides allow the discussion about aminoacids and their chemical functions. We focused not only in these protein forming units bit also on hydrolysis, peptide bond, and chemical interactions among aminoacids that lead to the formation of protein secondary, tertiary and quaternary structures (Fig. 3).Several links have been created through 10 alternative slides during program execution, for deepening chemical knowledge about inter- and intra-molecular hydrogen and covalent bonds.

Importantly, throughout the development of the material, we used chemistry principles oriented by our chemistry teachers to justify the knowledge presented by the biology teacher. This turned the theme broader and more concrete for students. According to the Brazilian National Curriculum [10], a broad understanding of chemical transformation also involves the search for explanations for the events studied, looking at microscopic models for explanatory interpretations.



(a)

(b)

Fig. 3. Screens of the multimedia material showing an amino acid forming groups (a) and peptide bonds and formation of the primary structure of a protein (b).

GETTING TEACHERS TOGETHER BY EVALUATING THE INTERDISCIPLINARY MATERIAL

D. Testing the Material in Locus: interaction and application

After the development of the material, we evaluated *in locus* the structural organization of the material and its relevance in the teaching-learning process (functional assessment) for approaching Biology and Chemistry. Therefore the material was used by three teachers Biology (1) and Chemistry (2) separately after reunions for deeply discussing the topics in both perspectives. Importantly each teacher has addressed all topics proposed in the material focusing on their own discipline without using all slides as the

purpose was not breaking the disciplinary practice but adjust it so the student is favored with the view of different aspects about the same subject. [11] discuss that interdisciplinarity does not nullify the specific knowledge, but demands from the educational professional the willingness to share it, conscious that is not the owner. Instead they should make it accessible and discursively understandble to others.

Teachers may not be or feel prepared to address certain subject considering another discipline perspective/view. According to [12] is necessary to prepare the educational professionals for working in a interdisciplinary way. Interestingly, the discussion about the material among our teachers before the use allowed the exchange of information and experiences that increased the view approached in each discipline specifically.

Each teacher presented the class using the slides necessary for the development of *Proteins* content in their discipline. At school 1, classes were taught in the computer room, where students organized in pairs, accompanied the explanation of each slide presented by the teacher at the computers. At school 2, the teachers presented the class with the material by using the data-show projection. Interestingly, no differences were observed in terms of performance and students participation. These two different ways of presenting the material revealed its versatility, which may be adapted to different structured schools. It is important to say that in college B, the group was only 12 students, which may have facilitated the development of the class, avoiding that they do slide transitions when they thought necessary. The level of accuracy ranged from 85 to 90% of index showing a significant advantage in the use of the material.

After the class presented by our teachers to 37 students of third grade of two high schools using the multimedia material, we collected their opinion by using a questionnaire. According to most students the material enlightened the topics following a sequence that facilitated the content understanding (97%). For all students, the activities proposed

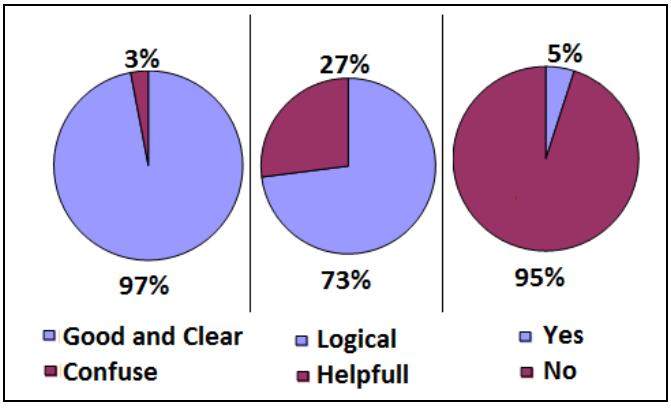


Fig. 4. Evaluation of the interdisciplinary multimedia material by High school students. Look and Structure (a); Organization and sequence (b); Something needs to change (c).

by the slides were clear and 95% would not change any of the slides at all (Fig.4).

According to 94%, the content was better understood with the use of the material, while 46% reported that the material was very useful for approaching the content. They also considered the figures very important to fully understand the content. Importantly, according to these students, all biology and Chemistry teachers should always use this material simultaneously (89%) (Fig 5).

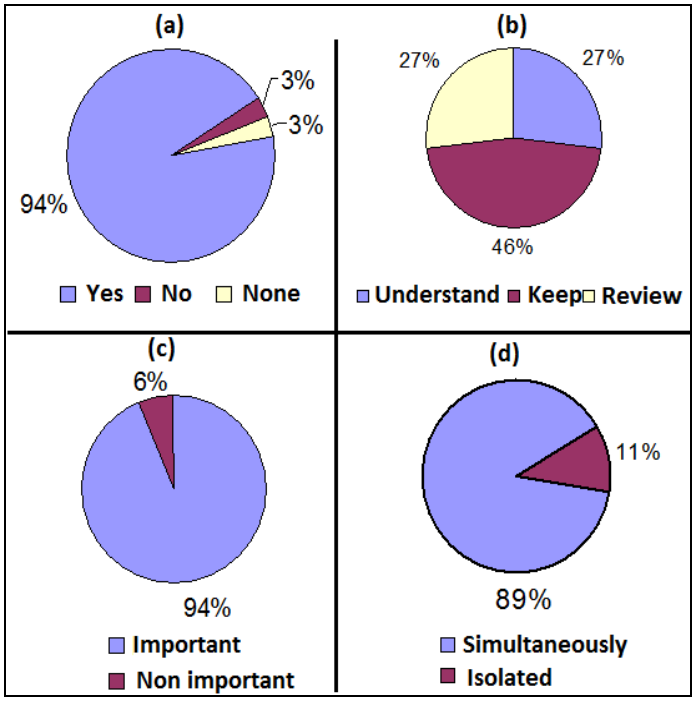


Fig. 5. Functional evaluation of the interdisciplinary multimedia material by High school students. Usefulness (a); Role about the context (b); Figures (c); How Teachers should use it (d).

At the end of the class, a brief interview about the material and the interdisciplinary lessons was performed with 27 students that accepted to talk. The speeches were always positive and some are reported below representing the majority of the students' speeches:

Student Q: "*I really enjoyed the slides, they were clear and we understand very well the lesson. The material really came to add a plus in the class.* "

Student R: "*In my opinion what was most different is that I always looked in the Internet proteins enrolled with those forms and we had already given the chemical bonds in chemistry. But now I could make that connection. I understood that the protein has its native form because it is formed by amino acids, which have different geometries that eventually culminate in that folded form. The coolest thing I think is this interaction between Biology and Chemistry for the knowledge where we associate one thing with another together with the teachers.* "

Student S: "*In every class, each teacher used this material.*

It would be good to use the same material for more than one discipline, as it comes the university entrance exam. This exam is increasing the demands for interdisciplinary analysis and the school should prepare us using this way. "

Student T: "*My question is: why in Biology class, sometimes I have doubts about some of the content appearing in Chemistry and the teacher cannot answer, and vice-versa? Because we want to know the biology mixed with chemistry and chemistry with biology.* "

Student U: "*The approach of the content was totally different from what I had seen*."

Student V: *"The effort of every teacher in assembling such materials should be rewarded. For my part I think the more the teachers offer and engage, the more they motivate us. No more use of the teacher curricular talking about "I already done the university exam". To see the teacher studying and worrying about new ways to teach us is always very exciting and inspiring.* "

The students statements revealed that they are interested in new ways of learning. We noticed that the interdisciplinary process, when actually applied by teachers together, encourages and assists the student in understanding the content of different disciplines. [13] reported that the implementation of an interdisciplinary project serves as a stimulus for students, since the topics are generally related to their reality, which thereby ends up making the study more contextualized and interesting, improving their behavior. Our experience using the interdisciplinary multimedia material, reinforced this hypothesis, not only for students but also for teachers, who felt gratified for the better understanding and behavior of the students (*e.g.* more questions and interest).

E. Testing the Material in Locus: learning the topic

In order to verify the material contribution in the process of teaching and learning, a questionnaire containing interdisciplinary questions were applied to all 37 students after the class presented by the Biology and Chemistry teachers using the interdisciplinary multimedia material. The result was compared with that from 47 students of the third grade of secondary education, who had a class about *Proteins* without using the multimedia material. This lecture was given by the Biology teacher only since *Proteins* is not a current topic of Chemistry discipline. For the 47 students, the teacher used resources such as textbooks and blackboard for approaching the topic. Importantly, the biology teacher who taught the classes was the same in all schools.

Our results pointed to a significant difference in the ability of answering the four questions with an increase of 22-34% in the groups using the material. These data pointed to the applicability of the same didactical material for teaching a subject in an interdisciplinary way.

Finally, teachers involved in projects similar to ours, which put them together to create methods and materials to use simultaneously, may be pleased with statements such as that from the student X:

Student X: "*Knowing that our teachers, who give us the base to supposedly "walk" by ourselves, do not get defeated and still study for teaching us is at least encouraging. This shows that just as we need them to achieve our goals, they need someone to reach their knowledge, and in this project it becomes clear that everyone benefits from knowledge, which helps us to create an autonomy not only for our studies, but also in life. The work that these teachers are doing is a striking example and this successful material, which by the way was very well done, has a great use for their students. The works like this encourage us to search, learn and be fascinated with that knowledge, when properly teaching is done.*"

IV. Conclusion

Our data showed that getting teachers together in the school for creating new and sharing didactical materials can be very productive for everyone, students and teachers. This approach also reinforced the need for investment in the development of teaching materials and strategies to increase the level of understanding of the students. This material is available for everyone, by asking through the e-mail labiomol2003@ yahoo.com.br.

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