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BUFFERLATOR: PRODUCTION OF A VIRTUAL LEARNING ENVIRONMENT AND CALCULATION OF BUFFERING SYSTEMS

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Abstract: Students at different levels of education usually have notable learning difficulties regarding the concepts and accounts that permeate the disciplines of chemistry, biology and mathematics. An example of an interdisciplinary topic covering the areas mentioned is the concept of a buffer solution. In order to minimize any remaining conceptual deficiency on the part of students and the public working in industries and laboratories, the project aims to create an online and interactive platform, where users can have access to the explanation of the theoretical contents that permeate the theme of buffer solution, in addition to interacting with an online calculator that, through information entered by visitors, will generate solution preparation data and will show the effects of adding an acid or a base, ionic strength and temperature in the calculations. The results will be presented with the necessary explanations, so that the user can instantly observe how the accounts are performed. The elaboration of this project is very relevant, since the calculations involved in the buffer solution are usually carried out in a simplified way, without correction of the errors added by the change in temperature and ionic strength of the medium. The proposal is based on the availability of free and quality content to a large number of people outside the academic community, enabling the IFRJ to carry out an effective scientific dissemination, in addition to promoting an active learning methodology to the students involved in the elaboration of the project, which permeate the concepts of chemistry, mathematics, biology, programming and design.
Keywords: Buffer Solution. Chemistry. Education. Schedule.

INTRODUCTION

Currently, there are several works in the literature that address students' difficulties in learning chemistry, as reported by Martina Nieswandt (NIESWANDT, 2006), who discusses students' interests and attitudes towards science, as well as their insights into how they can play important roles in developing a meaningful understanding of scientific concepts, that is, a mastery that would go beyond rote memorization. The systematic recording of concepts and formulas in the teaching of subjects that make up the natural sciences, and not necessarily the actual learning of the available content, was discussed by SANTOS et al. (SANTOS et al., 2013).

This occurs because the methodology currently used is not managing to promote a full understanding on the part of the students, given that they prioritize the evaluation and not the absorption of the content, being then harmed when entering the job market or even in school life. Many of these people, throughout their professional or academic careers, will resort to the internet to automatically resolve issues that were not fully absorbed by them. Despite the usefulness and ease of use of such tools, many of them will only generate the results without any explanation on the subject, thus corroborating the malabsorption of the content. In view of this, the use of learning mechanisms - different from those presented in class - is important for the student, since, in order to learn, it is necessary to be in contact with new stimuli in order to have brain plasticity (GOUVEIA and PARRA, 2016). Therefore, it is possible to observe that the quality and effectiveness of the contents and pedagogical methods must accompany the innovations brought by each historical context, and in the case of the 21st century, the focus of these novelties is present on the internet and its ability to store and generate various tools.

In this context, it was proposed the elaboration of an alternative, organized, fun and easy to apply didactic for the teaching of chemistry based on experimentation, interaction and theatricalization that allows a greater involvement and understanding of chemistry by children and adolescents, resulting in the elaboration of of the project entitled "ALTERNATIVE DIDACTICS IN CHEMISTRY TEACHING FOR CHILDREN AND YOUTH PUBLIC". From the previous project, data was collected and results were obtained that showed a systematic failure in the methodologies currently used in the teaching of chemistry. However, the introduction of alternative didactics, mainly involving the internet, proved to be a great option for the deconstruction of a paradigm about the difficulty in learning certain subjects, so a branch of the aforementioned project called "Bufferlator" was created.

From this challenge, the topic buffer solution was chosen. This content permeates some concepts related to chemistry, biology and mathematics, which are normally subjects considered difficult for students to understand. Some testimonies of students and professors were collected, obtaining numerous reports about the difficulty of learning the buffer solution by the students. Thus, it was decided to create a website with the necessary content so that there is a complete absorption of the different concepts that permeate the calculations carried out in the p repair and in the proper functioning of a buffer solution, together with an online calculator that can speed up the work. of the user, generating the necessary data for the production of different buffer solutions, normally present in the laboratory life of different technological environments.

In addition, the emergence of the virus that causes COVID-19 and its consequences, such

as the need for remote study, revealed the lack of excellent content in Portuguese on the internet. In this scenario, it is extremely important to offer alternative teaching materials, and of quality, especially due to the increase in this demand. Although there are some websites offering a buffer solution calculator – as is the purpose of the current project – such as www.liverpool.ac.uk and www.reachdevices.com/Protein/BiologicalBuffers.html, their content makes use of foreign language, in addition to the fact that they do not have resources to understand the calculations performed, a fact that demonstrates, once again, the extreme need to create content-generating channels that not only provide ready results, but encourage the user to observe how to perform the calculations behind the generated results, as well as providing information that the buffer solution calculators of the cited sites do not present, such as corrections of the errors aggregated by the change of temperature and ionic strength of the medium.

Thus, in order to minimize the problems presented, as well as the lack of knowledge of the calculations behind a buffer solution, and the absence of mechanisms present in other existing sites involving this topic, the proposal is based on the availability of a content free and of quality to a large number of people inside and outside the academic community.

OBJECTIVE

The Bufferlator aims to present to the public, in a didactic and precise way, concepts and calculations related to the buffer solution, mainly showing and avoiding the approximations normally carried out in relation to the variation of ionic strength and temperature in the reaction medium. In addition to compressing all the tools into a single, easily accessible online platform, in order to meet the demand of students of different educational levels, technicians, professors, researchers and workers in general who work in the broad areas of chemistry and biology.

MATERIALS AND METHODS

The Bufferlattor website consists of its structure, as a form of methodology, the use of a smart calculator, including contents and explanations of the topic, serving as a tool to help on the topic buffer solution.

Regarding the method used by the smart calculator, the visual tool Studio Code was used, which will be based on 3 languages: HTML (Hypertext Markup Language), CSS (Cascade Style Sheets) and Javascript. Regarding the HTML language, it will be responsible for structuring the page and the codes directing where each element must be. Defining, for example, what is text, what is a column and what is an image, what goes on top or what goes down. But just this language would make it look bad, like just a big text. And this way that CSS is present, it will give attractiveness to our creation, a mechanism used to give color, fonts, style, spacing, among others to a web document. Instead of putting formatting inside the document, this mechanism will link to a page that contains styles. And finally, Javascript is the programming language that will have as its function the ability to give movement and action to the page, working on the program's interactions, thus making everything more attractive to visitors. One can use as an example, the use of the calculator, in practice. When the user provides certain information about the buffer of interest and selects the "calculate" option, the result will be given (in html language) and this interaction is only possible due to the use of the Javascript language. And with these mechanisms, the calculator will be able to offer the necessary data for the production of different buffer solutions, counting quickly and faithfully to the data, in addition to allowing the efficient

operation of the entire Bufferlattor site.

Another method to be used is the presence of content, aiming to offer the user data containing advanced knowledge, such as the debye- Hückel law ((SCHELL et al., 2017, p.2151), (MANOV et al., 1943, p. 1765), (RING; KELLUM, 2019, p. 6521), (CAMORDY, 1961, p. 559)) in addition to handling numerous databases such as several handbooks and the National Standard Reference Data Series., answers and explanations of everything that is done to arrive at the result obtained, both in terms of mathematics and related content and on the buffer solution. This way, a step guide of the present calculations will be offered on the page, concerned with the understanding behind the values and the processes of how to arrive at them. With this objective, the platform will also provide content directly related to the topic: Chemical balance, acid-base theory and ionic strength, in addition to the ramifications of the buffer solution, which are the chemical and biological buffer.

Among the components and information on the site, topics for the application of the buffer solution in practice are also presented, in addition to the calculator, a guide of possible errors that may occur due to mechanical, physical or chemical errors will be presented. As well as a techniques tab, discussing laboratory techniques that require a tampon during your procedure. Finally, the presence of these contents as a methodology aims to stimulate the understanding and knowledge of this information, being presented in a didactic way, with the use of images and languages that will allow a greater understanding of the content, and even arousing a greater interest in the matter.

PARCIAL RESULTS

During the project, the site was being developed resulting in a prototype still under construction, available at the link: www.Bufferlator.netlify.app. In this, there is the initial page (Figure 1) in which the slogan phrase of the project is present in its center next to the Bufferlator (stylized erlenmeyer) that will stamp the entire site.

The creation of the featured erlenmeyer was ideal to complement the visual identity of the site. Since the personification of laboratory elements is intended to minimize the terror that students have in relation to the subjects covered by the project, making them create a less tenebrous bond - even if visual - with the subjects of chemistry and biology, corroborating for the main purpose of the website.

The different tabs of the site are available at the top of the screen, namely: Contents, Bufferlator, Table and About. In the contents tab (Figure 2), it is possible to visualize blocks with a summary of what will be possible to find about the approached subject, in addition to several Bufferlators characterized for each content. It is possible to observe 9 different contents which are: Chemical Equilibrium, Acid-Base Theories, Buffer Solution, Techniques, Chemical Buffer, Biological Buffer, Calculations, Ionic Strength and Errors. The first four have already been completed and the rest are under construction.

This section was designed to facilitate users' access to content related to buffering systems, organized chronologically, for a more effective and interactive reading. Because the contents were synthesized by high school students and reviewed by masters and doctors in the subject, the texts have a differentiated didactic so that students use the site as a support for their learning. Furthermore, all content can be downloaded in PDF format, so that the student is not restricted to using the internet and has the possibility to study offline.

On the next tab, Bufferlator, you can find the calculator, which has 5 different functions, namely: Buffer Calculation, pH Calculation, Effect of acid addition, Effect of base addition

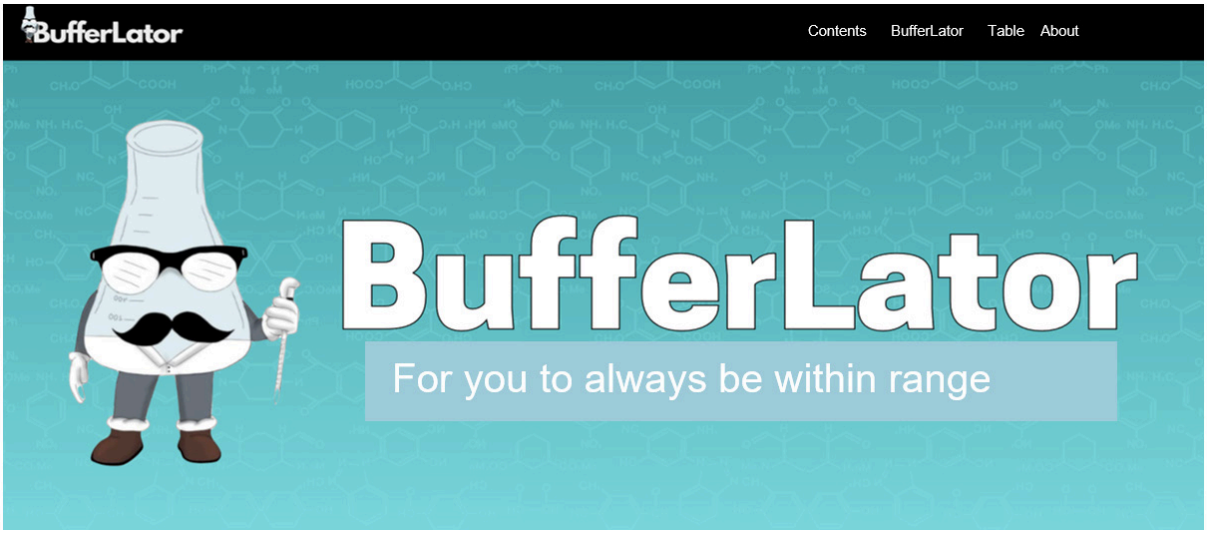

Figure 1 – Bufferlator website home screen

Source: Prepared by the authors.

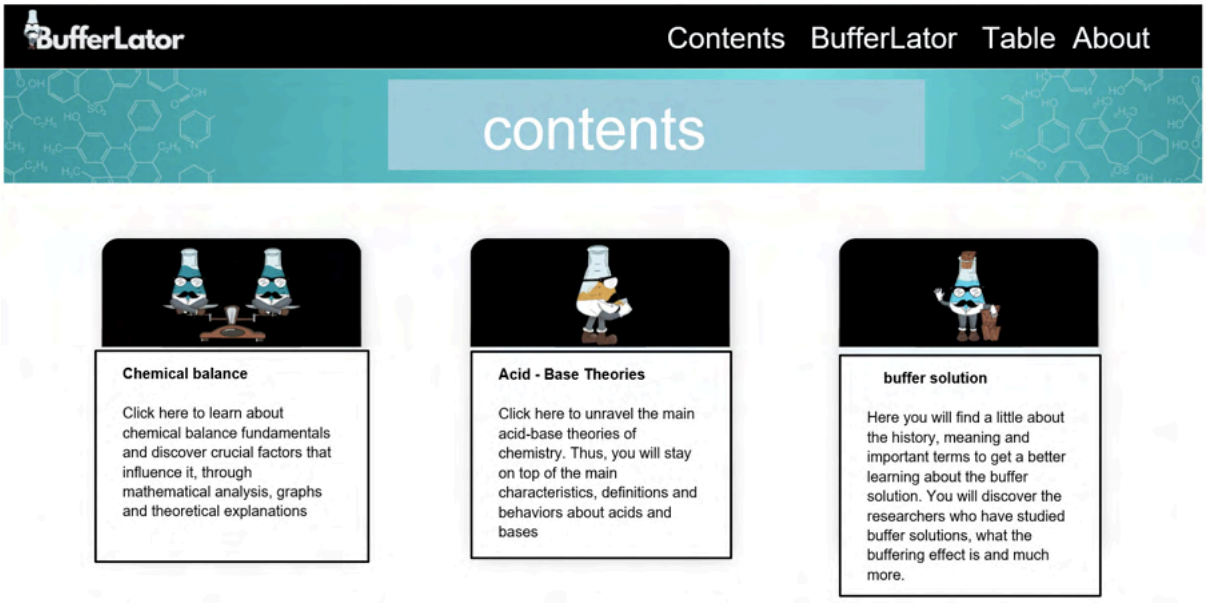

Figure 2 - Contents

Source: Prepared by the authors.

and Ionic Strength (Figure 3). An example of the use of one of the calculators is illustrated with the respective result obtained under conditions determined by the user, in this case with the influence of ionic strength and temperature (Figure 4). A PDF will be available for each calculation (figure 5) with its detailed result, which allows the user to confirm its veracity.

Note that the calculator was designed to be intuitive. This way, the data entry boxes are arranged with the appropriate captions to facilitate the addition of values from users. On the side, is the result generated by the calculator, equipped with a small recipe for the preparation of the selected buffer, where the mass of conjugate acid and conjugate base, volume of solvent, among other information that can be changed according to the chosen calculator. In addition, when wanting to resolve any doubts about the calculations, it is possible that, by clicking on the link "Click here to learn more!", the student is directed to the content tab and can review the concepts used in the calculation.

In the Table tab (Figure 6), there is a compilation of information about the buffers used by the Bufferlator, such as: pKa, dpKa / dT, molar mass of the reagents, in addition to curiosities about the buffer - organized in a table - being It is possible to perform a quick search of the user's preferred buffer through the search bar found above the table.

It is possible to find in this tab data that are difficult to access on the internet, which were taken from the literature and inserted on the website with the appropriate references. This will facilitate user research, saving time, as one of the site's proposals. In addition, the calculations performed by Bufferlator use data from this table, allowing the user to perform the calculations on their own in order to compare their results. This being one of the differentials that www.bufferlator.netlify.app, in relation to the other sites mentioned above, presents. Since the other sites do not clearly and concisely organize the data used to formulate their results.

Finally, there is the about tab (Figure 7), with specific information about the reasons that led to the creation of the website, an objective description of the functionality and the objectives that are expected to be achieved with the use of the visitor. In addition, photos are also present with brief descriptions of the members who made the project's progress possible, along with due acknowledgments to the financial supporters.

FINAL CONSIDERATIONS

As many studies pointed out earlier, the inclusion of new technologies in the teaching of chemistry proves to be a great learning tool. The current project is under construction, and it is a great challenge to integrate concepts related to programming, design and advanced chemistry calculations, such as the influence of temperature and ionic strength in the calculations for preparing aqueous solutions.

Bufferlator 's expectation is to add new functions and expand the number of biological buffers on the platform. For this virtual learning environment and calculations to become an object of reference in the scientific environment, a reliable source of data and a provider of research support, allied also with the objective of democratizing the teaching of basic science for the general public.

THANKS

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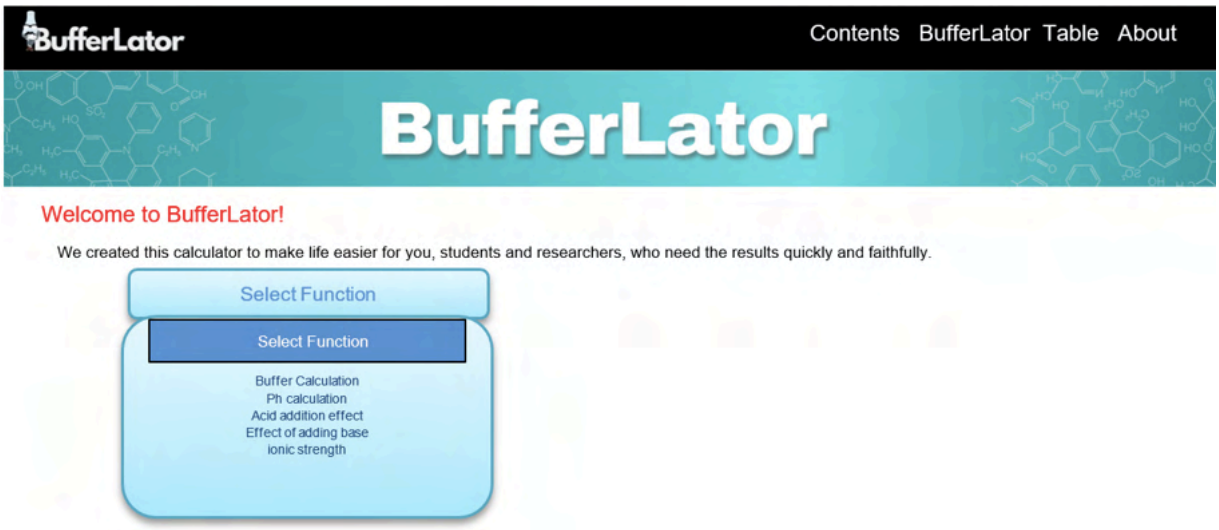

Figure 3 – Bufferlator.

Source: Prepared by the authors.

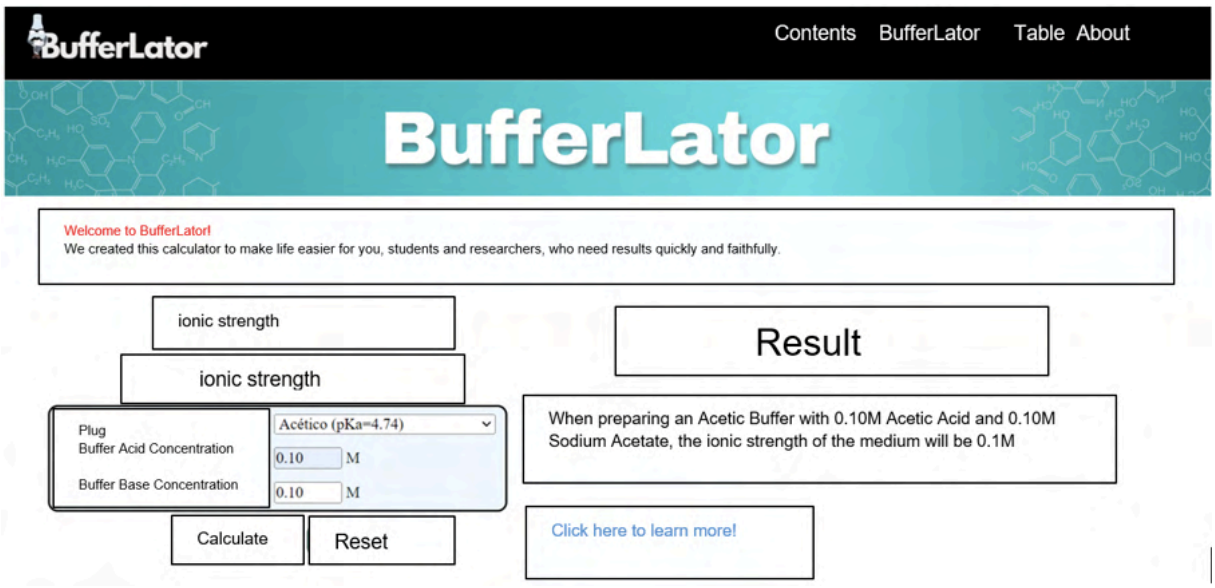

Figure 4 - Calculator response template

Source: Prepared by the authors.

$$z = 1,81925889\ x\ 10^{-6}\ mol/L\ de\ CH_3COO^-\ vindos\ da\ solução$$

$$[CH_3COO^-] = 0,100 + 1,81925889\ x\ 10^{-6} = 0,100001819\ \text{mol/L}$$

Força iônica

$$\mu = \frac{1}{2} \times \{[cátion] \times (carga\ do\ cátion)^2 + [ânion] \times (carga\ do\ ânion)^2 + [H^+] \times (1)^2\}$$

$$\mu = \frac{1}{2} \times \{[Na^+] \times (1)^2 + [CH_3COO^-] \times (-1)^2 + [H^+] \times (1)^2\}$$

$$\mu = \frac{1}{2} \times \{(0,100 \times 1) + (0,100001819 \times 1) + (1,81925889\ x\ 10^{-6} \times 1)$$

$$\mu = 0,100001819\ ou\ 0,10\ M$$

cation charge(carga cátion)

anion charge(Carga do ânion)

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Cátion(cation)

Figure 5 - Calculation of ionic strength of acetate buffer

Source: Prepared by the authors.

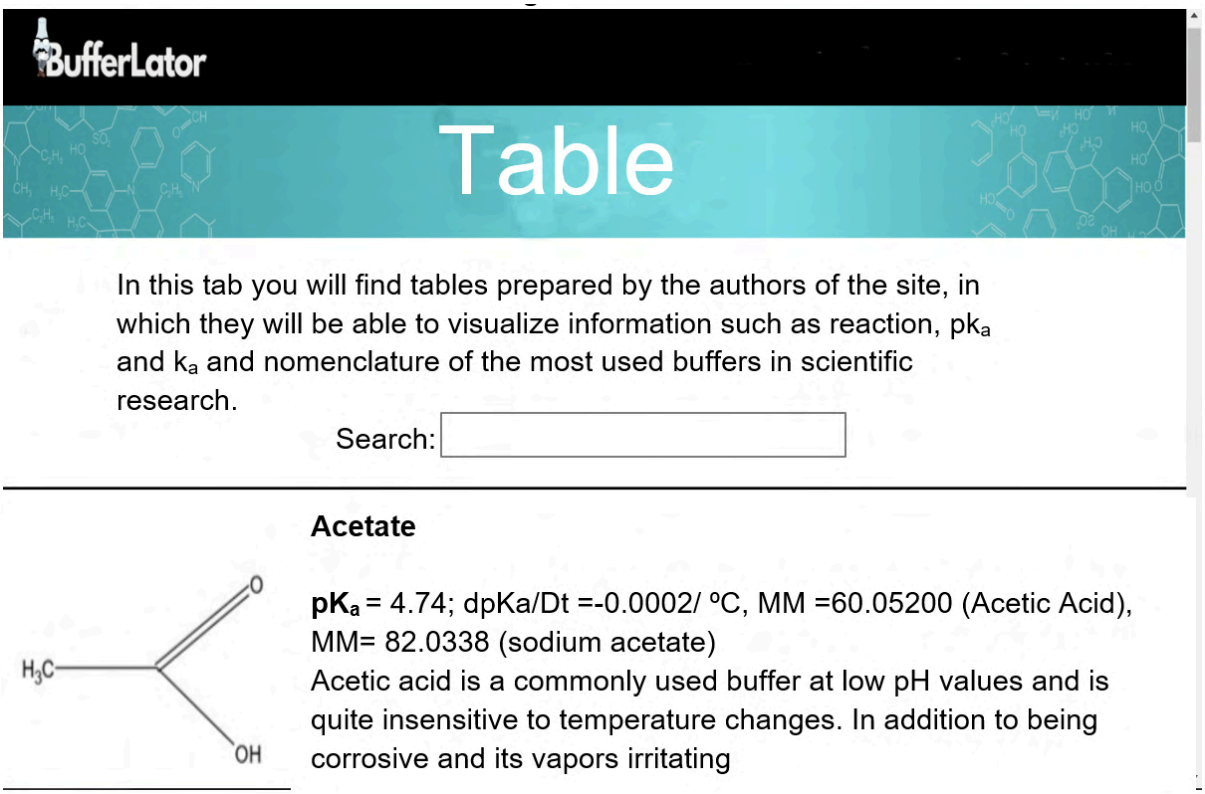

Figure 6 - Tables

Source: Prepared by the authors.

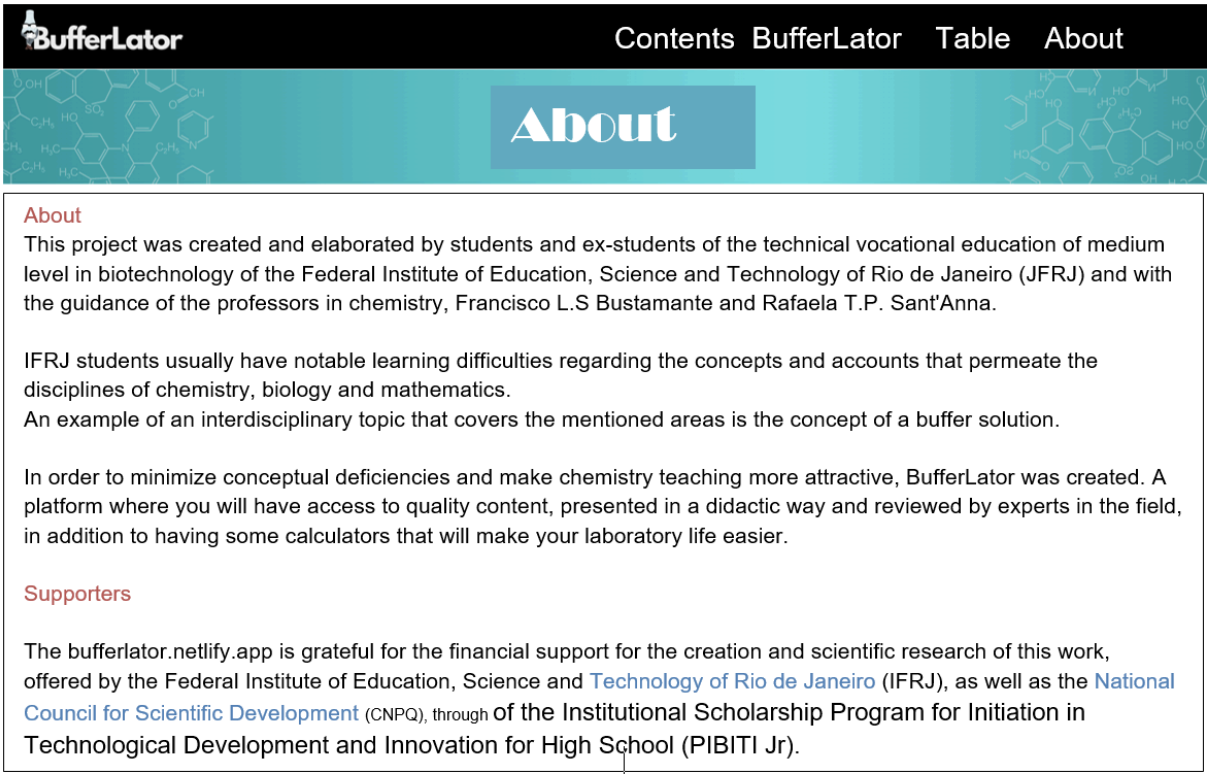

Figure 7 - About

Source: Prepared by the authors.

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