Digital booklet: contextualizing chemistry experimental practices in integrated high school

Cartilha digital: contextualizando as práticas experimentais da química no ensino médio integrado

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ABSTRACT
The Digital Booklets have been used as an auxiliary didactic and pedagogical resource in the educational praxis developed in the classrooms, in addition to being able to contribute as a didactic learning tool. On the other hand, in recent decades, research at area of dedicated teaching The search news approaches for teach chemical concepts, highlighting the interlocution between experimentation and contextualization, allied to the use of Technologies Digital from the Information It is Communication. This article presents a digital Educational Product designed and made available free of charge, containing experimental practices contextualized to the student's daily life for the discipline of Chemistry of the 1st (first) year of Integrated High School, mainly, in the inclusive perspective of the use of accessible and low-cost materials, cost and the search for an interdisciplinary approach to the suggested contents, thus guaranteeing the democratization of teaching and citizenship education.

Keywords: integrated high school, experimentation, learning objects, educational praxis, educational product.

RESUMO
As Cartilhas Digitais vêm sendo empregadas como um recurso didático e pedagógico auxiliar na práxis educativa desenvolvida nas salas de aula, além de poder contribuir como uma ferramenta didática de aprendizagem. Por outro lado, verificam-se nas últimas décadas as pesquisas na área do ensino dedicadas a buscar novas abordagens para ensinar conceitos químicos, destacando a interlocução entre experimentação e contextualização, aliadas aouso das Tecnologias Digitais da Informação e Comunicação.
Neste artigo, apresenta-se um Produto Educacional digital elaborado e disponibilizado gratuitamente contendo práticas experimentais contextualizadas ao cotidiano do estudante para a disciplina da Química do 1º (primeiro) ano do Ensino Médio Integrado principalmente, na perspectiva inclusiva da utilização de materiais acessíveis e de baixo custo e busca de uma abordagem interdisciplinar dos conteúdos sugeridos garantindo assim a democratização do ensino e a formação cidadã.

**Palavras-chave:** ensino médio integrado, experimentação, objetos de aprendizagem, *práxis* educativas, produto educacional.

### 1 INTRODUCTION

The didactic and pedagogical resources, in general, are tools that will help the teacher in the teaching and learning process. In this sense, the Digital Booklet emerges as an integral part, being a facilitating instrument to be used in the classroom, allowing the sharing of information regarding the didactic content, using strategies for the students' understanding. Within this perspective, the educational product, booklet, emerges as a resource, as it is a source of enlightening information and language accessible to the public (Santos, 2021: 53).

The use of different didactic and paradidactic resources has been indicated as a fundamental tool in the student's learning process, especially in Science Teaching which, being a multidisciplinary area, has a range of these resources (Vieira, Bianconi; Dias, 2005). Booklets and other complementary teaching resources have gained more and more space in schools, as well as in other environments (Nascimento et al., 2020).

To get an idea of this importance, the use of this resource has been guided by the National Curricular Guidelines for the training of Basic Education teachers and also by the National Curricular Parameters, which suggest the use of artifices and support tools that can innovate the process of teaching-learning (Brasil, 2002). The development of booklets is important to stimulate new educational strategies, constituting an important resource for the dissemination of information (Torres et al., 2009; Alves et al., 2014).

You objects in learning they are resources educational what they can to use any language or Format It is aim The mediation It is qualification at the process teaching and learning (Braga, 2015). It is observed that the advancement of Digital Technologies
of Information and Communication (TDIC’s) induces us to apply them in the educational system as a didactic tool of help at the process in teaching learning. For Oliveira, Amaral and Domingos (2011), this action can enable digital inclusion for the student, which is in fundamental importance for O development from the citizenship It is improvement of level of information It is knowledge. Furthermore, the technological resources available in educational institutions greatly facilitate the production of different didactic materials. Some allow interactivity, increasing the efficiency of environments and facilitating the teaching and learning process.

Per other side, corresponding to the assumption theorists what stand out the need for contextualization in Exact Science disciplines, especially in Teaching in Chemical, as quite for favor O process in learning It is promote the critical and citizenship formation of the student, as stated by Silva and Marcondes (2010). A contextualized teaching that has more meaning for the student can facilitate the development in skills It is Skills important for The your training as a citizen and learner (Carvalho Oliveira et. al., 2018). Allied to that, other authors, such as Leite and Lima (2015), Warth, Silva and Bejarano (2013), Santos and Mortimer (1999) It is Would make et al . (2009) yet defend what The contextualization, like this at teaching in general, must start from the reality experienced by students, as well as consider the prior knowledge of each one (Duart, 2007; Chassot, 2006), as the acquired knowledge can become a possible instrument for understanding and intervention in the environment where he lives and the previous knowledge stored during the life of one individual It is one big influencer at construction of your process in learning(Ausubel, 1980).

Allied to the contribution of a more contextualized Chemistry Teaching, its interlocution with the strategy of experimentation in the teaching of exact sciences and natural. In that sense, as highlight Luca et al. (2018), the experimentation constitutes a potential didactic tool, as it makes the student protagonist in the process of learning, values the habits of reading, writing, argumentation, skills practices in realization It is manipulation, allowed miscellaneous approaches in your planning and execution, highlighting the contextualization.
In this article, based on the relevance of Digital Booklets for the process and democratization of teaching and the interlocution between contextualization and experimentation strategies in Chemistry Teaching, a digital educational product designed and made available free of charge is presented, containing experimental practices contextualized to the student's daily life to the discipline from the Chemical of 1st (first) year of Teaching Medium mainly, from the perspective of alternative solutions such as the use of materials accessible and/or from low cost.

2 METHODOLOGY

The research has an applied nature because it proposes to generate an educational product with relative purposes and use records of knowledge generated by existing research/basic and technological content, which, according to Prodonav and Freitas (2013), justify the characteristics of scientific research of a nature pure and applied. Therefore, it is understood that this research is characterized by a qualitative nature. Namely, qualitative research aims to delve into the world of meanings of human actions and relationships, a side that is not perceptible and cannot be captured in equations, averages and statistics (MINAYO, 2001).

The elaboration work of the Digital Booklet took place following the stages of elaboration, formatting, the choice of contextualized practices and, finally, the construction. Figure 1 presents a schematic of the steps taken to build the educational product.
From figure 1, it can be observed that the work was developed following three central axes: (1) the realization of the prospective study, aiming to consult the scientific literature on the theme “interlocution of contextualization and experimentation strategies in Chemistry Teaching” to create a bibliographic contribution for the development of the educational product. For this, a search and analysis of publications (articles) was carried out in the Portal de Periódicos of CAPES (Coordination for the Improvement of Higher Education Personnel) and other databases.

Then, (2) the General Chemistry experiments were selected and carried out. The experiments were researched in textbooks and paradidactics of Chemistry and Experimental Chemistry present in the study contribution, seeking those based on the use of accessible and low-cost materials. Concomitantly to this stage, (3) consultations were carried out on scientific dissemination websites and magazines, highlighting Revista Ciência Hoje, Revista Química Nova na Escola (although it is not a scientific magazine, it presents numerous texts on scientific dissemination in chemistry) and Revista Ciência Elementar, with the purpose of composing the contextualization and problematization part of the Digital Booklet, in addition to the search for the inclusion
of transversal and interdisciplinary themes to the suggestions of contextualization and problematization of the contents addressed.

Finally, the Digital Booklet was prepared and formatted, which was registered as a digital book with ISBN (*International Standard Book Number*): 978-65-00-28750-9. In order to share and disseminate the educational product licensed in the digital environment for free and virtually, it was decided to deposit it in the EduCAPES Repository, this *site* is an online educational portal of open educational objects for use by students and teachers of basic, higher and post-secondary education. undergraduate students who seek to improve their knowledge (EduCAPES, 2023).

Initially, a case study would be carried out at the Federal Institute of Education, Science and Technology of Maranhão (IFMA), on Campus Codó and would have, as universe from the search, you students of 1st (first) year of classes of Secondary Education integrated with Vocational Education. However, with the difficulties imposed by the Covid-19 Pandemic, it became impracticable The execution from the search from the manner previously outlined, one turn what the educational institution, as well as the other components of the Network Federal Education, had to paralyze your student activities, in research and extension. About the pandemic of the infectious disease Covid-19, resulting from the *Sars-Cov-2* virus, detected in November 2019 and which spread rapidly throughout the world:

[...]*This* fact forced the World Health Organization (WHO), on December 31, 2019, to declare a public health emergency of international importance and, on January 30, 2020, the world pandemic was characterized. To contain it, WHO has recommended basic actions, such as: use of masks, social distancing, treatment of identified cases, massive tests, among other individual and social care. In view of the global context, the Ministry of Health in Brazil issued Ordinance No. 188, of February 3, 2020, declaring a public health emergency of national importance, due to the possible infection of the new coronavirus in Brazilian citizens (Gonçalves & Avelino, 2020: 5-7).

To get an idea of the situation experienced at the time, Figure 2 presents an overview of new cases and deaths confirmed daily per million people from the moments of greatest occurrence until the present moment of writing this article.
These data reveal that Brazil and other countries are facing a serious Public Health problem due to the COVID-19 Pandemic, with Brazil unfortunately leading the statistics of new daily deaths per million people between the end of February and the beginning September 2021 when comparing with the respective numbers of countries in Europe, North and South America, Asia and Africa.

Figure 2. New daily confirmed cases and deaths from COVID-19 per million people.

The return of activities during the pandemic occurred with the Emergency Remote Teaching Establishment (ERE), where students and teachers were successively resuming their face-to-face activities in accordance with the determinations of the health authorities and deliberations of the school management. At the beginning, practically all classes took place remotely, through synchronous and asynchronous classes, that is, with the presence of the teacher and student at the same time through a virtual platform of meetings or activities requested from students. This measure was taken because it was not possible to say precisely and in a short or medium term when face-to-face classes would return, so it would depend on how the contamination and transmission rates were forwarded to each region affected by the disease (Arruda, 2020).
Despite the difficulties faced during the development of this work, the Digital Booklet built with Basic Education students can be applied to demonstrate the applicability and relevance of its use in educational practice, based on a case study involving the teaching of the content *Acidos and Bases*. The subjects of the research were a class of twenty-two students of the 1st (first) year of Integrated High School in the Professional Education of Young People and Adults (PROEJA) modality of the Federal Institute of Education, Science and Technology of Maranhão (IFMA), on Campus Codó.

### 3 RESULTS IT IS DISCUSSION

The Digital Cartilha was built trying to establish a simple and easy-to-understand language especially for Integrated High School students. It received the name of “CHEMISTRY CONTEXTUALIZED EXPERIMENTS BOOKLET” in *E-book format*. Figure 3 shows the format of its cover and summary, respectively. The digital booklet has 14 (fourteen) didactic experiments for the subject of General Chemistry, especially for the 1st (first) year of High School, presenting, including, suggestions for The contextualization It is problematization of practices experimental:

![Figure 3. Cover (a), summary (b) of the Digital Product “Digital Booklet”.

Source: Authors (2023). Available at http://educapes.capes.gov.br/handle/capes/643377]
The structuring of the digital booklet presents the following modules: (I) presentation and clarifications and guidelines. In this initial part, the teacher has a didactic-methodological contribution on the use of contextualization strategies combined with experimentation in the teaching and learning process and their interlocutions in Chemistry Teaching; (II) by understanding the relevance of these two associated teaching strategies, the professional will be able to choose the appropriate experiment to use according to the didactic sequence practiced with their students.

In this interface, you experiments It is suggestions in contextualization It is problematization were made according to the main contents of Chemistry worked in the 1st (first) year of High School (Mixtures and Solutions, Density, Atomistics, Forces intermolecular, Acidity It is Basicity It is reactions chemicals); finally, (iii) at the end of the booklet, information on the product authors educational.

In each section of the experiments, it was divided into four stages, on which the teacher can deliberate according to his educational practice and the school’s infrastructural conditions. As an example of applicability, an experimental educational practice on acid-base content and neutralization reactions with Integrated High School students will be discussed below, as summarized in Figure 4.
Figure 4. Acid-base educational practice developed in Integrated High School.

In this educational practice, the content approach began by providing (i) subsidies for contextualization and problematization, leading students to reflect on the substances in acids and bases present in their daily life, from food to hygiene and cleaning products. This stage was relevant, as it instigated the raising of questions among themselves about these new concepts that make it possible to classify common everyday substances.

It is at this point in the practice that the relevance of contextualizing and problematizing what is being taught is shown, since it is not intended to teach ready-made knowledge for the student to merely memorize, that is, it is not simply knowing what an acid or a base is, but understanding why a certain chemical substance is an acid or base, and of course, considering the level of deepening necessary for the development of the student to the grade studied.
Given this perspective, students were encouraged to think about why chemists classify these chemical substances. At this time, the concept of pH scale was introduced, which values the substances assume to be classified as acidic, basic and neutral. The students were then encouraged to experience this chemical phenomenon (ii) using materials previously prepared by the professor, easily known by the students, to carry out the qualitative identifications, using red cabbage extract.

It should be added that the experiment was carried out in the classroom, since the school did not have a laboratory to carry out the experiment, however it was carried out under the supervision of the class teacher.

After carrying out the experiments suggested in the digital booklet, the students were invited by the professor to another moment of discussion so that they could chemically understand what happened and what the color change of the substances meant when adding red cabbage extract (Brassica oleracea L.) to the analyzed substances and their relationships with pH and classification of chemical species.

The discussions between the professor and the students were based on this perspective so that together they could arrive at the answers to the initial questions based on information provided by the contextualized experimentation. In this educational practice, the use of the prepared digital booklet proved to be a mediating tool in the teaching practice and in the student's learning, since it helped in the interlocution between experimentation and contextualization within the didactic sequence outlined here, which does not prohibit the teacher from deliberating on which methodological strategy to employ, and may even be associated with other methodologies of school pedagogical work.

This experimental educational practice was similarly applied with students of Integrated High School in the Professional Education of Youth and Adults (PROEJA) modality of the Federal Institute of Education, Science and Technology of Maranhão (IFMA), at Campus Codó (Figure 5), who were attending the 1st year of Integrated High School.
Figure 5. Acid-base educational practice developed with students of the 1st Year of High School in the Youth and Adult Education Modality (PROEJA).

The results achieved were observed by Integrated High School students during and after carrying out the experimental practices suggested by the digital booklet, which can be grouped into educational practice based on praxis, that is, on the inseparability between theory and practice, allowing to build together with students an expository class with dialogue with the elaboration of questions, discussions on the theoretical and practical level considering the reality of young and adult students, which made the way of teaching the acid and base content more appropriate, without merely presenting the conceptual exposition of the chemical concepts.

In fact, it was observed, from the interlocution between contextualization and experimental practice, a greater involvement of the students, as they can relate known chemical substances notably with chemical concepts that were until then abstract for
these students. The teacher's mediating and facilitating role in this process is also highlighted.

In these two case studies, the digital booklet made it possible for the teacher to have a tool to work with the subject in order to interconnect contextualization and experimentation not only in a mechanistic conception, presenting ready-made knowledge for students to memorize to reproduce in a test, but introduce a necessary discussion for a deeper conceptual understanding of the contents related to the chemical knowledge of reality. It is also emphasized that this learning object is not intended to exhaust or delimit discussions in the classroom between teacher and students.

Thus, it is expected that the digital booklet will indeed be an educational tool, that is, a instrument for the use of didactic strategies that favor discussions in the contents studied in this first stage of Teaching Middle Integrated in form Theenable the promotion of a more attractive, contextualized and citizen.

4 CONSIDERATIONS FINALS

The use of different teaching strategies can enhance learning of the students. This digital booklet is not sought, much less encourages the use of a teaching methodology based on the mere reproduction of established knowledge, as well as the reduction of the act of experimenting to the mere execution of a script, on the contrary, it seeks the intelligent use of this approach based on the use of learning objects.

This digital booklet can be used in different educational contexts of High School from the teaching planning (even in the final years of Elementary School), in a perspective of allowing the discussion and production of knowledge, can contribute to arouse scientific interest in students, demystify the degree of difficulty that is generally stigmatized by lay people in relation to the contents of Chemistry, enabling the student to understand the contents of Chemistry in a manner practice It is facilitator.
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