Virtual learning environment with offline resources

Flávia Linhalis
PECIM & NIED/UNICAMP
Campinas, Brazil
flalin@unicamp.br

André Constantino da Silva
IFSP & NIED/UNICAMP
Hortolândia, Brazil
andre.constantino@ifsp.edu.br

Carlos Adriano Vieira
IC/FEEC & NIED/UNICAMP
Campinas, Brazil
carlosadrianovieira@gmail.com

Lucas E. de Lima Vascon
FEEC & NIED/UNICAMP
Campinas, Brazil
lucasvascon@outlook.com

Matheus Lima Santos
IMECC & NIED/UNICAMP
Campinas, Brazil
m174589@dac.unicamp.br

ABSTRACT

The situation of social isolation due to the Covid-19 pandemic has brought implications and worldwide concerns in several spheres - income inequality, social, gender, access to education and to knowledge. In the area of education, one of the actions that were taken to deal with the pandemic was the suspension of presential classes. It led to a series of situations that highlighted the challenge of giving everyone the opportunity to have access to technology and to knowledge. Many people were excluded for not having access (or a stable access) to the Internet, which motivated us to investigate platforms that would allow offline study. This article aims to describe the Educa Offline Platform, a Virtual Learning Environment (VLE) that is in its beta version and has, as a differential, requirements and features to allow offline navigation and to work with intermittent networks. We describe and discuss the design and implementation of a VLE with a reduced but essential number of tools, with a more dynamic and intuitive interface, consistent with the current web users, but without giving up the organization that a distance learning course needs.

Author Keywords

Virtual Learning Environment (VLE); Offline; Internet; Digital Inclusion; Resilience.

ACM Classification Keywords

•**Applied computing ~ Education ~ Learning management systems**; •Information systems ~ Information systems applications ~ Collaborative and social computing systems and tools ~ Open source software

INTRODUCTION

The COVID-19 left inequalities even more evident in underdeveloped countries - inequality of income, social, gender, access to education, etc. According to UNESCO [11], before the pandemic, Latin America and the Caribbean was already the most unequal region in the world. Specifically with regard to access to knowledge, the pandemic reinforced more than ever that we need inclusive education systems, designed to build resilience to the future challenges we may face.

It is estimated that more than 32 million children live in households that are not connected to the Internet. The heterogeneous nature of our societies means that experiences differ depending on the contexts of Internet access, digital skills, educational opportunities, and inequality in each country [11].

For example, while 70% of households in Uruguay own a computer and 64% have Internet access, Internet access levels are below 30% in the Plurinational State of Bolivia, Cuba, and El Salvador [11]. In Brazil, 28% of households still do not have Internet access and 58% of the population accesses the Internet only via smartphone. In rural areas and in the poorest classes this number is even higher - 79% of people in rural areas and 85% of the poorest classes use only a smartphone to access the Internet [4]. This reality shows that, in these regions, when we talk about remote learning, we are referring to learning that will often take place over a smartphone, using an intermittent network.

When thinking about scenarios where connectivity is not possible or limited, choosing platforms that enable offline

work and study can make a difference for a significant audience.

During social isolation, online platforms were a mandatory educational response to school closures, but less than half of households in the Latin American and Caribbean region have a stable connection to the Internet or a computer [11]. The transposition of face-to-face classes by non-face classes using information and communication media and technologies in higher education became known as Emergency Remote Learning [5].

In this movement that happened in a hurry, there was a popularization of digital information and communication technologies, with the growth of the use of tools that allowed academic activities to continue. Videoconferencing tools, previously little present in the daily lives of teachers and students, in pandemic became necessary and even mandatory to join remote teaching. The Virtual Learning Environments (VLE) also stood out as to an intense demand [9].

According to Linhalis and colleagues [6], VLEs are tools that enable remote access to a set of learning activities to be developed by students - viewing videos, reading texts, participating in discussion forums, among others, which allow classes to be asynchronous.

Anchored in the Sustainable Development Goals of the United Nations Organization (ONU), number 4 and number 10, about Quality Education and Reducing Inequalities [12], we seek in our studies to (re)think the VLEs to the moment of social isolation we lived, with a solution that works resilience, equity and sustainability for distance and blended education.

More specifically, in this article we describe the Educa Offline platform, a Virtual Learning Environment (VLE) that is in its beta version and that has as differentials requirements to allow offline navigation and to work with intermittent networks, as well as responsive interfaces that adapt to the screen size of the device, which enables its use in smartphones, tablets and laptops.

OFFLINE RESOURCES AND VLE

Is it possible to have a VLE that works offline? The very nature of VLE expects that a connection to a server must exist in order to interact with the system. It is not possible, therefore, to work "totally offline" using a traditional VLE like Moodle, Google Classroom, Edmodo, etc. But it is possible to work with an intermittent network or offline moments, where the VLE is resilient when it loses the Internet connection. In addition to the VLE being resilient, students and teachers also need to prepare themselves in some moments of interaction.

In offline scenarios, interaction can be divided into three parts: before going offline, offline, and after going offline. The "before offline" part refers to the period when students and teachers have an Internet connection. Therefore, all the features of the application are accessible and this is the time to prepare for the offline work. This is done by accessing the courses of interest in the VLE and saving the resources that will be needed for offline work [7][1].

Offline time is the period in which the user has no access to the Internet. In such a situation, students and teachers perform their work in applications that do not need a connection to work. When the Internet connection is established again, the work that has been done can be synchronized with the platform.

To allow offline scenarios, simple content replication, which allows course browsing through local copies, is not a guarantee of success, as content can be changed by teachers and/or students while the application is offline. For this reason, it is necessary to perform synchronizations with a server when the application finds an available network. Furthermore, when thinking about low-bandwidth scenarios it is desirable that large files (mainly videos) are processed and returned to the client at lower resolutions [6].

In a previous work, conducted by the group, a methodology to evaluate offline resources in VLEs was described and evaluated [6]. As detailed in the methodology, navigation, synchronization, and processing requirements are necessary considering mobile or non-mobile devices, as explained in the remainder of this section.

The navigation requirements are intended to allow the user to browse a course offline. This requires keeping a cached history of pages accessed, allowing downloading of a course, as well as developing interfaces that show the user which files are available for offline access and which are not.

The synchronization requirements are intended to allow the user to make changes in the course while offline - to write a comment or to upload a file, for example; and to perform synchronizations with the server when the application encounters a network. In this situation, the VLE can provide features to facilitate offline work, for example, putting a post on hold and automatically resuming it when the connection is re-established, without requiring any further interaction from the user.

Processing requirements are intended to do some processing on files before sending them over the network. For example, if the user wants to upload/download a very large video, the system will have to lower its resolution, according to the available bandwidth.

EDUCA OFFLINE PLATFORM TOOLS

Since the 1990s, our research and development group has been working with methodologies and tools for distance and blended education. We had a very rewarding experience with research, design and development of the TelEduc VLE [13], which took place between 1997 and 2017 at the Nucleus of Informatics Applied to Education (NIED) in partnership with the Institute of Computing (IC), both at the University of

Campinas (UNICAMP). Based on the TelEduc development experience, we have been working on the development of the Educa Offline platform [2] since 2018, aiming to offer a leaner and lighter system, without giving up the organization that a distance learning course demands. Our intention is to design an environment that can continue operating even without Internet connection, with a reduced but essential number of tools, with a dynamic and intuitive interface, consistent with the current web users accustomed to the use of social networks.

TelEduc's project was guided by a contextualized education methodology, elaborated by NIED researchers, based on constructionism [10] and developed in a participative manner, bases that we have taken to the Educa Offline project [2].

Before starting the design of Educa Offline, we conducted the "prioritization workshop" to identify a simplified set of tools to compose the "core" of the platform, which should be lean and lightweight [3]. Working with a lean set of tools is important in offline scenarios, as we need to deal with the challenge of having the user's device to host the courses. We need students and teachers to download the course and its files on their devices (mobile, tablet, laptop) to make offline browsing possible; i.e., the course resources must "fit" on the users' device.

To prioritize our lean set of tools, we invited to participate in the workshop four teachers with experience in using TelEduc and other e-learning environments, five students used to having their undergraduate courses supported by e-learning environments, and a researcher, responsible for conducting the planned activities. Our goal was to gather a small, but experienced, number of people so that we would have enough time to listen and discuss the ideas that emerged. In this sense, we consider this group of people to be representative, since it includes the roles of teacher and student [2].

We had to design a lean and light system, but without giving up the organization that a distance or blended course needs. In addition, we tried to think of a dynamic and intuitive application, consistent with today's web users, who are used to shorter and faster interactions. People no longer enter a web application to explore its features; they enter with a specific goal, for example, "I want to get the professor's material", and so they do.

The collective design of the homepage showed the importance of interactions: the timeline was pointed out as the central element of the interface, an influence of social networks in the practices experienced by teachers and students today, giving visibility to the interactions between course participants (see Figure 1). The interactions between people (timeline and participants/profiles) and their activities conceptually sustain the interface project of the Educa Offline Platform [2]. It was in this direction that we worked.

With these requirements in mind and with the know-how acquired from the development of the TelEduc VLE, we had some tools prioritized, described in the remaining of this section. Each of the tools has a set of requirements, which varies according to the users' permissions/role (Administrator, Teacher or Student). In the Figures are shown print screen of the tools in the beta version of the system (September/2022), available at https://proteo.nied.unicamp.br/prod/.

Timeline: A communication tool, where you can make targeted posts to specific students, groups, or everyone (Figure 1).

Notifications: In the Educa Offline Platform, the traditional mail was substituted by a timeline, a dynamic message board (Figure 1) allied with a notification system that sends an alert whenever the user receives a post, similar to social networks timelines.

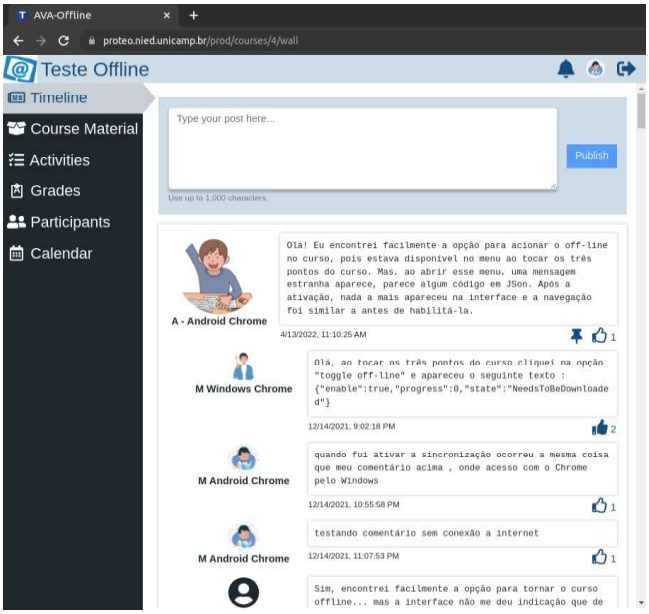

Figure 1 - Educa Offline timeline, showing desktop version and teacher role.

Activity tool: This is a tool where the teacher posts the tasks that must be done and delivered by the students. Figure 2(a) shows the main screen of the tool, where the teacher can create new activities or tasks.

Calendar: Shows the events (e.g., a task delivery) in a calendar format (Figure 2(b)).

Course Material: Illustrated in Figure 3(a), this is a very important tool in a VLE, because it is where teachers place the course material: class slides, articles, media news, among other material of interest in the course.

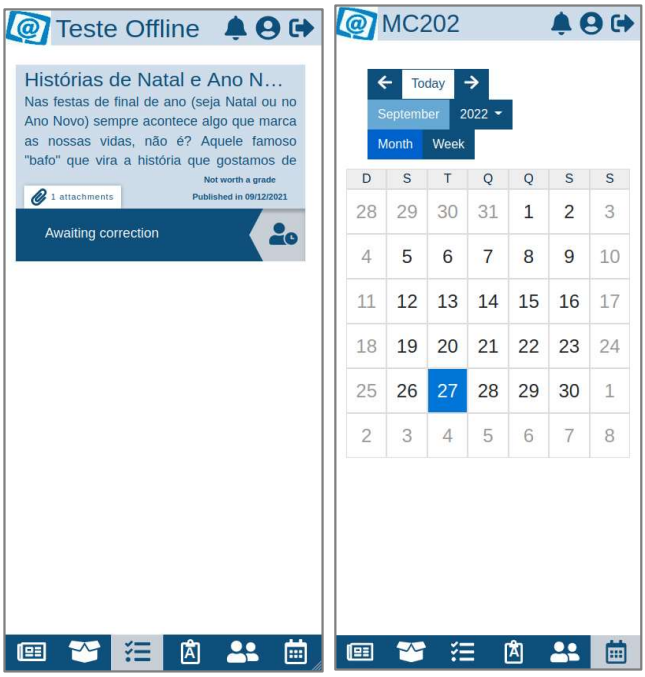

Figure 2 - (a) Activities Tool and (b) Calendar Tool, both for smartphone version and teacher role.

Grades: This tool is used by teachers to assign grades and for students to view them (Figure 3(b).

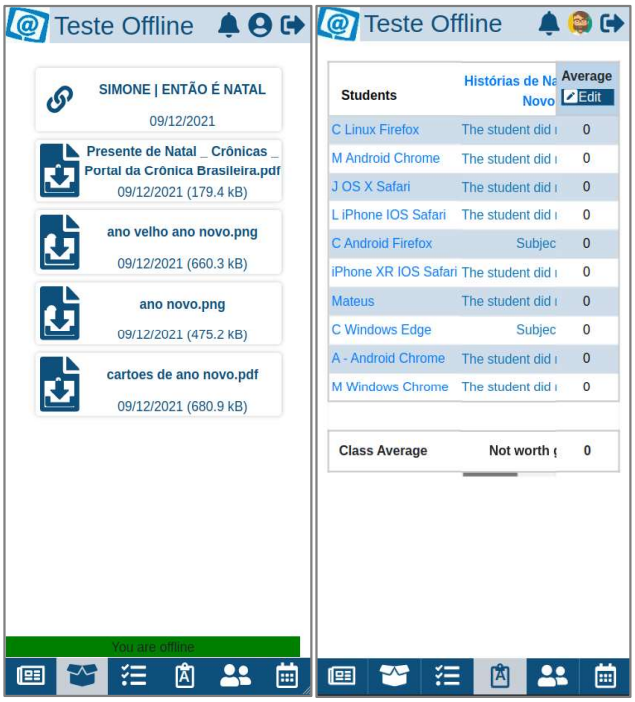

Figure 3 - Course Material Tool and (b) Grades Tool, both for smartphone version and teacher role.

Whenever the user is offline, the system displays a green line at the bottom of the screen with a message indicating that the user is offline, as illustrated in Figure 3(a). Other offline features and requirements are signaled in the interface with the symbols shown in Figure 4 and exemplified in Figure 5.

Figure 4 - Icons used in the interface to show offline and synchronization features.

Figure 5 -Examples of the synchronization icons in the Activity tool.

EDUCA OFFLINE PLATFORM ARCHITECTURE

The Educa Offline Platform consists of a client-server web application, totally developed with open source technologies, as illustrated in Figure 6. On the client side (or frontend), the software is being developed with the latest web technologies to allow the application to be resilient to loss of Internet connection. The following technologies were used for the development of the Educa Offline Platform on the client side, to enable offline navigation:

- Angular PWA: Angular is a framework that encompasses several tools to facilitate the development of complex web applications. The PWA library makes it possible to save site data locally for offline browsing.

separation allows easily maintenance of the source code and

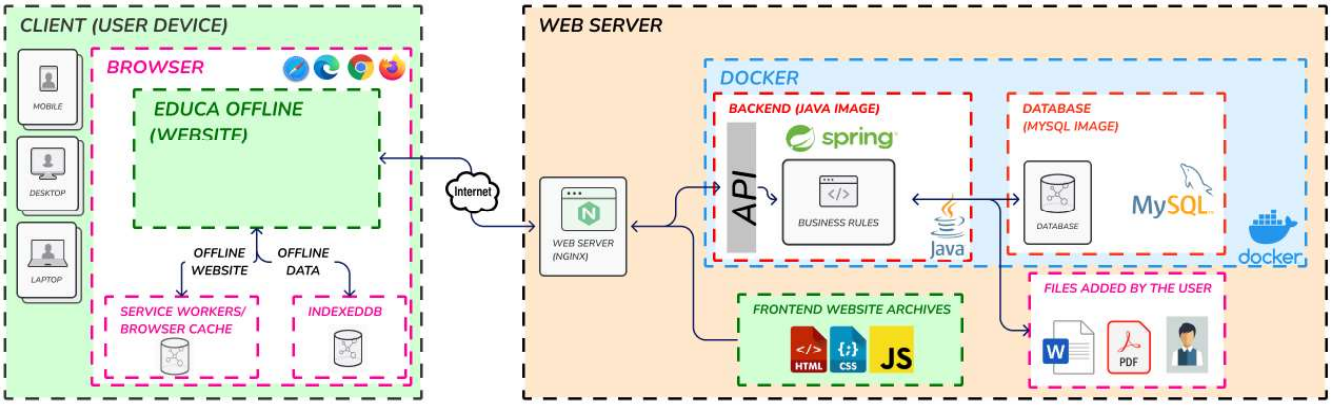

Figure 6. The Educa Offline Platform Architecture - a client-server web application.

- NGRX: It is an application status management library. It is used to save and organize data received over the Internet and organize it to synchronize changes when the Internet connection returns.

Development is being done with responsive interfaces [8], which can adapt to the screen size, allowing the Platform to be used on smartphones, tablets and laptops/desktops without having to create specific applications.

With the increase in the processing power of mobile devices, the responsive interfaces has been gaining space, since it is necessary to render the web pages and make the necessary adaptations at the client, depending on the screen size. The advantage is having only one source code, which greatly facilitates maintenance and version control. Since the source code is the same, one expects to have the same functionality in the VLE when accessing it through the browser on different devices, which is not always the case, as different browsers may have access to a different set of hardware resources. Therefore, differences between devices and their browsers need to be considered by the development team, even if the source code is the same.

On the server side (or backend), we used tools to organize courses, user data and to handle permissions. The following technologies were used for the development of the Educa Offline Platform on the server side: Java Spring Boot, Maven, Spring Data JPA, MySQL, Spring Security and OAuth2.

On the backend, a Rest API was created with the purpose of responding to several endpoints and answering the requests made from the interface on the frontend, in order to expose its data to the client.

The Educa Offline Platform client-server web application uses the MVC (Model-View-Controller) software pattern. The main advantage of MVC is separation of concern - the application is divided in Model, Control and View. This the software implementation can be better divided among many developers work at a time.

In this section, we showed the Educa Offline prototype version, a VLE that is resilient to loss of Internet connection and that can operate on different types of devices, with responsive interfaces. We still need to incorporate accessibility features, group tool, processing requirements, and perform tests in real situations.

CONCLUSION

Education is a human right, a central pillar for sustainable development, a key to promote social and labor inclusion and to reconcile economic growth, equality and participation in society. With the pandemic, more than ever before, the importance of access to connectivity and digital devices to ensure continuity of learning, as well as continuity of professional and social life, has become evident.
The issue of digital inclusion is broad and complex, with a strong call to action. Beyond technological solutions such as Educa Offline, it requires, above all, political will, collaboration between policy makers, educators, and communities [11].

It is important to learn from the pandemic crisis and think about resilience with innovation, so that education systems are prepared to react quickly, to support those most in need, and to guarantee the continuity of learning, prioritizing the most vulnerable populations and those most at risk of exclusion, helping to reduce socio-educational gaps. With these gaps in mind, in this article we present the Educa Offline Platform prototype, a VLE that is resilient to loss of Internet connection.

The platform is being developed according to the trends and technological advances in the area of web development. Its design assumptions highlight the influence of social networks in the practices experienced by teachers and students today, working with your peers in an integrated and interactive way. Finally, regarding the development of

offline resources, we hope to have an open source platform designed for an audience that deals with intermittent access to remote learning and, consequently, provide a more inclusive access to education and knowledge.

ACKNOWLEDGMENTS

We thank the Educa Offline team, who helped the design and implementation of the platform. Authors 1 and 2 gratefully acknowledge the grant #2021/06846-5 from São Paulo Research Foundation (FAPESP).

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