Journal Applied Computing 8[22]1-7: e40822107
Article

Web application for learning Zapotec DIIDXAZÁ

Aplicación web para el aprendizaje del Zapoteco DIIDXAZÁ

Rafael-Pérez, Eva*[a], Pineda-Nivón, Aimée Jahdaí[b], Díaz-Sarmiento, Bibiana[c] and Villalobos-García, Julio César[d]

[a] Tecnológico Nacional de México- Instituto Tecnológico de Oaxaca • LFT-4107-2024 • 0000-0003-2793-1254 • 905268
[b] Tecnológico Nacional de México- Instituto Tecnológico de Oaxaca • LFT-6091-2024 • 0009-0008-3721-1342 • 2066173
[c] Tecnológico Nacional de México- Instituto Tecnológico de Oaxaca • KZU-9558-2024 • 0000-0002-3521-2041 • 731036
[d] Tecnológico Nacional de México- Instituto Tecnológico de Oaxaca • AAS-3279-2021 • 0000-0001-5800-9655 • 657390

CONAHCYT classification:

Area: Social Sciences
Field: Business and administration
Discipline: Administration and management
Sub-discipline: Business administration

https://doi.org/10.35429/JCA.2024.8.22.1.7
Article History:
Received: January 30, 2024
Accepted: December 31, 2024

* ✉ [pilar.jimenez@upvm.edu.mx]

Abstract

Web applications have become a fundamental tool for learning today. The goal of the "Web Application for Learning Zapotec Diidxazá" is to facilitate flexible learning, starting from the user's interest in an interactive and playful way. The incremental methodology was used, whose philosophy is to build by gradually increasing the program's functionalities. This model focuses on delivering an operational product with each increment (Mills, 1999), from the communication, planning, modeling, construction, and deployment phases. The results are: A trilingual dictionary with audio, a multilingual bidirectional translator, an object detector, and a real-time image translator using artificial intelligence, along with learning sessions, assessments, and playful games. The web application is a platform that helps facilitate and promote the learning of Zapotec and, in the future, preserve the linguistic and cultural heritage of the Diidxazá variant.

Objective	Methodology	Contribution
- Facilitate learning in a flexible way, starting from the user's interest in an interactive and playful manner	- Incremental Phases: - Communication - Planning - Modeling - Construction - Deployment	- Facilitate and promote the learning of Zapotec. - Preserve the linguistic and cultural heritage of the Diidxazá variant

Web Application, Zapoteco Diidxazá, Learning

Resumen

Las aplicaciones web en la actualidad se han convertido en una herramienta fundamental para el aprendizaje, el objetivo de la "Aplicación web para aprendizaje del zapoteco diidxazá" es facilitar el aprendizaje de forma flexible partiendo del interés del usuario de forma interactiva y lúdica. Se utilizó la metodología incremental, su filosofía es construir incrementando las funcionalidades del programa. Este modelo se centra en la entrega de un producto operativo con cada incremento (Mills, 1999), desde la fase de comunicación, planeación, modelado, construcción y despliegue. Los resultados son: Un diccionario trilingüe con audio, un traductor bidireccional multilingüe, un detector de objetos y un traductor de imágenes en tiempo real utilizando inteligencia artificial, sesiones de aprendizaje, evaluaciones y juegos lúdicos. La aplicación web es una plataforma que permite facilitar y promover el aprendizaje zapoteco y en un futuro preservar así el patrimonio lingüístico y cultural de la variante diidxazá.

Objetivo	Metodología	Contribución
Facilitar el aprendizaje de forma flexible partiendo del interés del usuario de forma interactiva y lúdica	- Incremental Fases: - Comunicación - Planeación - Modelado - Construcción - Despliegue	- Facilitar y promover el aprendizaje zapoteco. - Preservar el patrimonio lingüístico y cultural de la variante diidxazá.

Aplicación Web, Zapoteco Diidxazá, Aprendizaje

Citation: Rafael-Pérez, Eva, Pineda-Nivón, Aimée Jahdaí, Díaz-Sarmiento, Bibiana and Villalobos-García, Julio César. [2024]. Web application for learning Zapotec DIIDXAZÁ. Journal Applied Computing. 8[22]-1-7: e40822107.

ISSN 2531-2952/© 2009 The Author[s]. Published by ECORFAN-Mexico, S.C. for its Holding Spain on behalf of Journal Applied Computing. This is an open access article under the **CC BY-NC-ND** license [http://creativecommons.org/licenses/by-nc-nd/4.0/]

Peer Review under the responsibility of the Scientific Committee MARVID®- in contribution to the scientific, technological and innovation Peer Review Process by training Human Resources for the continuity in the Critical Analysis of International Research.

RENIECYT
Registro Nacional de Instituciones y Empresas Científicas y Tecnológicas
1702902 CONAHCYT

Introduction

In today's world, Learning and Knowledge Technologies (LKT) have significantly impacted how users learn by interacting with web applications through a systematic and user-friendly process. According to Lujan (2002), a web application is defined as a set of resources and tools that users can access via a web server through the internet, using a browser.

The main objective of the web application for learning the Diidxazá Zapotec language, is to preserve the Diidxazá Zapotec language through an accessible learning experience, offering various learning sessions and different interactive resources such as active listening, interactive exercises based on user interests, as well as real-time object and text detection and translation using artificial intelligence.

Its importance lies in cultural preservation, as the application significantly contributes to the preservation and revitalization of the Diidxazá Zapotec language. It facilitates the inclusion of Zapotec-speaking communities in society by providing access to educational resources that allow more people to learn Diidxazá, while also protecting linguistic diversity by offering Zapotec-speaking communities a tool to safeguard their language.

This web application is an innovative solution in a client-server environment, developed in response to the growing concern over the loss of Diidxazá Zapotec speakers. It introduces a new way of learning that enables people to learn, preserve, and promote the language of indigenous communities.

The features of the web application focus on the use of technology and innovative resources for language preservation. It incorporates advanced technologies like artificial intelligence and convolutional neural networks to create an interactive and effective learning environment.

Using the web application facilitates the teaching-learning process of Diidxazá, meaning that the learning occurs based on user interest and in a playful manner. Additionally, the application is highly accessible, as it can be used by a wide range of users, allowing for learning at any time and from any location.

The application is based on the pedagogical model of critical theory through the project method, which makes it more effective for independent language learning, allowing users to construct their own knowledge.

Mexico is one of the countries with the greatest cultural and linguistic diversity in the world, with 68 indigenous languages and 364 linguistic variants, which have been recognized as languages since 2013 (Algarabía, 2023). However, approximately 70% of these languages are at risk of disappearing, a situation that is unacceptable (Secretaría de Cultura, 2019).

In the state of Oaxaca, there are 11 indigenous languages, including Zapotec, which, with 62 variants, is the second largest group within the Oto-Manguean family (Secretaría de Cultura, 2020).

The identified issue centers around the decline in Diidxazá Zapotec speakers. Despite being a cultural and linguistic heritage in Mexico, this variant is at risk of extinction, classified as Level 3, meaning that only 18.47% of the population between the ages of 5 and 18 are speakers of this language (INALI, 2019). This alarming figure suggests that, in 50 years, the intergenerational transmission of the language will be almost nonexistent.

Another issue is that the decline in speakers is attributed to various factors, including migration, marginalization, globalization, and the predominant use of dominant languages like Spanish or English. Discrimination is also a problem, as there are cases where people who speak indigenous languages are stigmatized or treated unfairly in various aspects of life.

According to Orta et al. (2020), the user experience in software development is something that will enable the creation of applications with an attractive, effective, and efficient design aimed at achieving the project's objective. In the case of the Zapotec language, it will also serve as an element of inclusion, allowing speakers to participate in the project and highlight their identity as an Indigenous people through the resources generated.

ISSN: 2531-2952
RENIECYT-CONAHCYT: 1702902
ECORFAN® All rights reserved.

Rafael-Pérez, Eva, Pineda-Nivón, Aimée Jahdaí, Díaz-Sarmiento, Bibiana and Villalobos-García, Julio César. [2024]. Web application for learning Zapotec DIIDXAZÁ. Journal Applied Computing. 8[22]-1-7: e40822107. https://doi.org/10.35429/JCA.2024.8.22.1.7

This will help them recognize their importance in preserving Zapotec culture, as well as increase the number of digital resources available to the community. The lack of opportunities for people to learn the language is due to various factors, including the difficulty of finding the time and resources to learn the language through in-person courses.

This paper covers the following sections: methodology, development, conclusions, declarations, conflict of interest, author contributions, availability of data and materials, acknowledgments, abbreviations, and references.

Methodology

There are various development methodologies available for software creation. Maddison (1983) defines a software methodology as a set of philosophies, phases, procedures, rules, techniques, tools, documentation, and training aspects for information systems developers.

However, when implementing classical methodologies in medium-sized projects with higher demands for response times and imprecise, changing requirements, inefficient results are often produced. This is because more time is spent focusing on design and controls than on addressing potential changes in specifications, which are often incompatible with the analysis and documentation processes. This makes software development an unproductive and inefficient process (Pérez, 2011). Therefore, it is important to note that not all methodologies are suitable for every project, as they depend on the particular needs and context of each case.

The development of the Web Application for Learning the Diidxazá Zapotec Language was based on the incremental software methodology (Mills, 1999). The incremental model focuses on the progressive growth of functionality. That is, the product evolves with each planned delivery until it meets the client's or end user's requirements (Santander, 2024).

In this context, Pressman (2010) states that the incremental model applies linear sequences in a staggered manner as the schedule progresses. Among the concurrent activities is the specification phase, in which the requirements are gathered, and specific information for that increment is collected. This is followed by analysis and design, leading to the development phase in the chosen programming language. Finally, the results obtained are validated against the initial requirements of the increment, and intermediate versions of the system are delivered. These iterations are repeated until a product that satisfies the client's needs is achieved (Martínez, et al., 2008).

Development

In the development of the web application, three increments were executed through the phases of communication, planning, modeling, construction, and deployment.

The communication phase involves continuous collaboration with the client to clearly understand and define the project requirements. In this case, the general and specific objectives for each increment were established, project scopes and limitations were defined, and both functional and non-functional requirements were identified for the Translation, Learning Sessions, Communication and Games, Forum, Object Detection, and User Management modules.

To identify functional and non-functional requirements, the user story technique was employed. According to Cohn (2016), "a user story is a representation of a requirement written in one or two sentences using the user's common language."

During the planning phase, resource and time estimates were made, and the obtained requirements were interpreted and validated. A schedule of activities was created for each increment, establishing task timelines, deadlines, and deliverables for the various modules: Translation, Learning Sessions, Communication, Games, Object Detection and Text, Forum, and User Management.

ISSN: 2531-2952
RENIECYT-CONAHCYT: 1702902
ECORFAN® All rights reserved.

Rafael-Pérez, Eva, Pineda-Nivón, Aimée Jahdaí, Díaz-Sarmiento, Bibiana and Villalobos-García, Julio César. [2024]. Web application for learning Zapotec DIIDXAZÁ. Journal Applied Computing. 8[22]-1-7: e40822107. https://doi.org/10.35429/JCA.2024.8.22.1.7

The modeling phase focuses on the design and architecture of the software, ensuring that the proposed solution is viable and aligns with the project objectives. During this phase, various UML diagrams (Sequence, Class) were designed, an entity-relationship diagram and relational model were created, the database was developed using PostgreSQL, and graphical user interfaces were designed.

Regarding the architecture of the web application, it is based on a client-server model. According to Lujan (2002), on one side is the client (the browser or viewer) that makes requests, and on the other side is the server (the web server) responsible for responding to these requests. A single computer hosts the Hypertext Transfer Protocol (HTTP) service, along with the business logic (the application specifications), data logic (how data is accessed), and the actual data.

In the construction phase, the software is developed according to the design and tested to ensure compliance with the established requirements. In this case, the modules were coded using JavaScript and React Native, an open-source framework.

For the Object Detection module, artificial intelligence was applied through a convolutional neural network for image detection and recognition, as well as automatic translation using the COCO-SSD model. The use of artificial intelligence is briefly mentioned here as it will be discussed in more detail in a future article

It is important to note that the interactive learning sessions and playful games in the web application are based on the pedagogical model of critical project-based theory. Ramírez (2008) asserts that "critical pedagogy considers the educational process from the context of communicative interaction; it analyzes, understands, interprets, and transforms the real problems affecting a particular community" (p.109).

In the current context, Jolibert (1995) states that project-based pedagogy constitutes a formative strategy that allows breaking away from traditional school models and the roles of teachers and students.

It establishes a democratic approach and a pedagogical process in which all participants are involved from planning to execution and evaluation of the project. This method also aims to achieve meaningful learning, which can be developed within a specific area consistent with this pedagogical approach. This topic will be addressed in another future article.

User-centered testing was conducted to validate the functionality of the application at each increment, as well as to train the artificial neural network for image recognition.

Finally, the deployment phase involves implementing the increment in the production environment, ensuring that the software is operational and available for use.

Results

As a result of the development of the web application, various modules have been integrated, as illustrated in Figure 1.

Box 1

Figure 1
Modules of the Web Application

The Learning Sessions and Assessments module contains interactive lessons covering key areas of the Diidxazá Zapotec language, including vocabulary and pronunciation, as well as videos and audio recordings. It allows users to track their progress and assessments in language learning, providing instant personalized feedback, as shown in Figure 2.

ISSN: 2531-2952
RENIECYT-CONAHCYT: 1702902
ECORFAN® All rights reserved.

Rafael-Pérez, Eva, Pineda-Nivón, Aimée Jahdaí, Díaz-Sarmiento, Bibiana and Villalobos-García, Julio César. [2024]. Web application for learning Zapotec DIIDXAZÁ. Journal Applied Computing. 8[22]-1-7: e40822107. https://doi.org/10.35429/JCA.2024.8.22.1.7

Box 2

Figure 2
Learning Sessions and Assessments

Additionally, the application features a dictionary with various advanced search options and trilingual voices, enabling users to listen to and learn the correct pronunciation of words in Diidxazá Zapotec, Spanish, and English, as visualized in Figure 3.

Box 3

Figure 3
Trilingual dictionary

Furthermore, it includes a Bidirectional Multilingual Translator for translating between Diidxazá Zapotec and Spanish or English, allowing users to translate phrases and words, as seen in Figure 4.

Box 4

Figure 4
Bidirectional multilingual translator

Figure 5 demonstrates the implementation of the Object Detector module, which utilizes artificial intelligence for the automatic translation of an image selected from the photo gallery or taken in real time with the camera.

Box 5

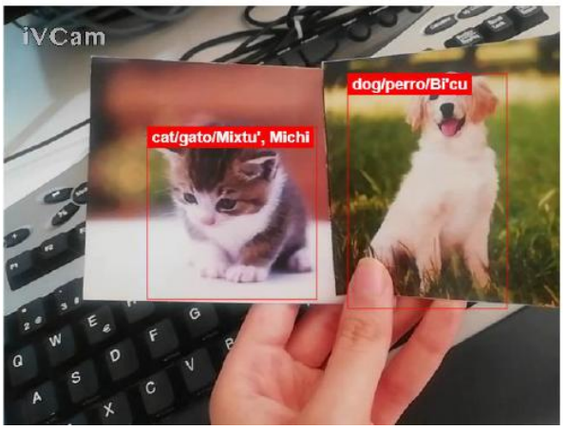

Figure 5
Object detection and image translation

Several interactive games have also been implemented, such as word searches, crosswords, and word ordering games, to practice and reinforce the concepts learned in Diidxazá Zapotec. An example is shown in Figure 6.

Box 6

Figure 6
Word Ordering Game

Finally, the collaborative forum module allows users to create new posts by adding a title, content, and selecting a category.

ISSN: 2531-2952
RENIECYT-CONAHCYT: 1702902
ECORFAN® All rights reserved.

Box 7

Figure 7
Collaborative Forum

Conclusions

The completion of this project represents a crucial step in the preservation of the Diidxazá Zapotec language, effectively addressing the concerning decline in speakers and the loss of this ancestral language through the innovative use of new technologies.

The web application for learning Diidxazá Zapotec has not only provided an interactive and accessible educational resource but has also become a catalyst for cultural revitalization. Its impact transcends technological and educational boundaries, enhancing the appreciation and preservation of this ancestral language within the community.

The application enables interaction in over three languages, making it more inclusive and accessible for users from diverse linguistic backgrounds. It significantly contributes to the preservation and revitalization of Diidxazá Zapotec by facilitating the inclusion of Zapotec-speaking communities in society, providing access to high-quality educational resources that enable more people to learn Diidxazá.

Despite challenges such as the lack of prior teaching resources and technological barriers, the web application for learning Diidxazá Zapotec has proven to be a viable and effective solution. It is noteworthy that the application is already available on the server for use. Regarding future work, there are plans to enhance the real-time object detection module to recognize endemic flora and fauna from the municipalities where Diidxazá Zapotec is spoken, as well as to increase the number of identifiable objects.

Finally, there are projections to expand the application to include other variants and indigenous languages from Oaxaca and Mexico.

Declarations

Conflict of interest

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Author contribution

Rafael-Pérez, Eva: Contributed the project idea, technical advice, conducted research, designed the application, and reviewed and validated the tests and functionality of the project.

Pineda-Nivón, Aimée Jahdaí:
Contributed to the project's development, the design and implementation of module testing, as well as the review and editing of the work.

Díaz-Sarmiento, Bibiana: Contributed to the review, editing, and preparation of the results.

Villalobos García, Julio César: Contributed to the review and validation of the pronunciation of the Zapotec language.

Availability of data and materials

For further information, please contact: eva.rafael@itoaxaca.edu.mx

Acknowledgements

We would like to express our recognition and gratitude to the Director of the "Melchor Ocampo" Primary School, Professor Celiflora Rafael Pérez, for her guidance on the application of the Project-Based Critical Theory Pedagogical Model through information technologies. We also extend our thanks to the third-grade students who used the application for learning Diidxazá Zapotec to test its functionality and enhance it with their contributions. Special thanks to Teacher Águeda López Castillo, a native of the Municipality of Unión Hidalgo, for her invaluable support in lending her voice to record the Zapotec language audios for the functionality of the modules in the application.

ISSN: 2531-2952
RENIECYT-CONAHCYT: 1702902
ECORFAN® All rights reserved.

Additionally, we thank the National Technological Institute of Mexico, which, through the Oaxaca Campus, has provided the space and resources for the development of this project.

Finally, we appreciate the collaboration and dedication of the authors, professors, and students who participated in the research, culminating in the results presented here. Our objective is to share these findings with the academic community and the general public regarding the work being developed at our institution from an academic and educational perspective.

Abbreviations

COCO-SSD	Common Objects in Context - Single Shot Multibox Detector
LKT	Learning and Knowledge Technologies
HTTP	Hypertext Transfer Protocol
SQL	Structured Query Language
UML	Unified Modeling Language

References

Antecedents

Orta, José Francisco, Ochoa Somuano, Jorge, Cruz-Maldonado, Omar, Ayala, Angel Antonio, López-Vásquez, Ángel, and Menendez-Ortiz, Alejandra. (2020). Development of Mobile Applications for the Preservation, Promotion, and Dissemination of the Zapotec Language.

Basics

Cohn, M. (2004). User Stories Applied for Agile Software Development. Boston: Pearson Education, Inc.

Luján Mora, S. (2002). Web Application Programming: History, Basic Principles, and Web Clients. Editorial Club Universitario.

Maddison, R. N. (1983). Information System Methodologies. Wiley Henden, 1983.

Martínez Torres, M. R., Toral Marín, S. L., & Borrero García, F. J. (2008). Study and Analysis of Distribution Lists in Open Source Software Projects as a Means of Knowledge Sharing. Investigaciones Europeas de Dirección y Economía de la Empresa, 14(3), 79-90.

Mills, H. D. (1999). The Management of Software Engineering, Part I: Principles of Software Engineering. IBM Systems Journal (2.3), 289 – 295.

Pérez, O. (2011). Four methodological approaches for the development of RUP Software – MSF

– XP – SCRUM. Inventum Magazine. No. 10, 64-78

Pressman, R. (2010). Software Engineering: A Practitioner's Approach (7th ed.). McGraw Hill.

Santander (2024). Software Development Methodologies: What Are They?

Supports

Algarabía. (October 9, 2023). Algarabía. Indigenous Languages are also Languages.

Instituto Nacional de Lenguas Indígenas (INALI). (2019). Mexico. National Indigenous Languages at Risk of Disappearing: Linguistic Variants by Risk Level.

Ramírez Bravo, R. (2008). Critical Pedagogy: An Ethical Way to Generate Educational Processes. Folios, (28), 108-119.

Secretaría de Cultura. (February 18, 2019). Mexico is One of the Countries with the Greatest Linguistic Diversity in the World.

Secretaría de Cultura. (February 26, 2020). Indigenous Languages of Mexico Against Extinction. Government of Mexico.

ISSN: 2531-2952
RENIECYT-CONAHCYT: 1702902
ECORFAN® All rights reserved.