A Modern Online Learning Platform for ʻŌlelo Hawaiʻi Classrooms

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Abstract

We present Hōʻoi Aʻo, a browser-based platform designed to streamline the teaching workflow and enhance the learning experience for students in Hawaiian language classes. Built with modern technologies including FastAPI, React, and MongoDB, the platform provides an intuitive and specialized environment for both instructors and students of ʻŌlelo Hawaiʻi. Our platform enables instructors to add content, create or import quizzes in multiple formats, view and analyze common student mistakes, and ultimately save time through automatic grading. Students can access chapters, lessons, assignments, and quizzes all in one place, with automatically graded quizzes for instant feedback and unlimited randomly-generated practice questions created using an innovative synchronous context-free grammar approach, allowing students to obtain extra language practice outside of class. Currently, the platform supports content from Book 1 of *Nā Kai ʻEwalu*, a popular Hawaiian textbook. Hōʻoi Aʻo not only makes language practice more accessible for a language with few existing learning resources, but also represents a step toward a more modern and effective digital ecosystem for teaching and learning ʻŌlelo Hawaiʻi.

Keywords: language education, Hawaiian language, indigenous language, context-free grammars, learning platform

1. Introduction

Language teachers often spend a significant amount of time manually grading coursework. This process is time-consuming and often monotonous, especially for questions that have clear-cut answers. At the University of Hawaiʻi at Hilo, a wide range of Hawaiian language courses are taught, from beginner-level courses for those without any knowledge of the language, to advanced courses for fluent speakers geared towards developing the next generation of language educators Instructors of these courses often spend several hours a week manually grading quizzes and assignments, including even time during the weekend. Such activities have been shown to decrease teachers' quality of life, physical and mental health, and relationships with their families (Moos and Wiener, 2025). This time could instead be devoted to developing new instructional materials or offering personalized support to students.

The primary efforts to revitalize the Hawaiian language have been conducted in a classroom setting, from language immersion schools for young children, K-12 schools, and at the university level. These approaches traditionally have not employed much technology. Only recently have there been some efforts to apply technology to Hawaiian language learning. For example, ʻAha Pūnana Leo, the organization that runs Hawaiian language immersion schools across the state of Hawaiʻi, has developed an app for parents and students to review common vocabulary words and phrases. Besides the usual course management systems (CMS), however, there are no systems designed specifically to help teachers teach Hawaiian.

With these considerations, this paper presents Hōʻoi Aʻo, a browser-based learning platform specifically for instruction of Hawaiian. For students, this platform provides a central location for course materials and assignments contained in Nā Kai ʻEwalu, the leading Hawaiian language textbook. Students can practice reading and writing the language via built-in exercises, as well as exercises randomly generated from context-free grammars, which are beyond the textbook's limited examples. For teachers, this platform features automated grading for quizzes, which reduces teacher workload and provides students with immediate feedback. Quiz scores and answers are stored so that the teacher can see a summary of common student mistakes, which can be addressed during in-person class sessions. Integrating these features into a single environment allows our platform to streamline the instructional workflow and enhance the learning experience for both instructors and students of ʻŌlelo Hawaiʻi.

2. Related Work

The use of technology to aid language learning is well-studied in the field of Computer-Aided Language Learning (CALL). For an overview of CALL, we direct the reader to surveys such as Golonka et al. (2014) or Farr and Murray (2016). Several studies have shown a need for CALL systems to have personalized feedback (Dodigovic, 2005; Heift and Schulze, 2007), which is one component of our work.

A similar initiative to ours is the OpenLang Net-

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work, an online platform designed to teach various European languages to Europeans, with the purpose of breaking language barriers when crossing into different countries within the EU (Mikroyannidis et al., 2023). Our platform focuses on Hawaiian, a critically endangered language spoken mainly in Hawai'i, USA, and aims to address pain points of both teachers and students of the language.

In terms of technology specifically for Hawaiian, there are few existing tools. Kuene (Walker et al., 2025) is a web-based dictionary editing and publishing platform designed to facilitate the creation of new Hawaiian words by the Hawaiian Lexicon Committee. Other recent work has developed machine learning approaches to convert between two Hawaiian orthography systems: an older one developed in the 1800s when Hawaiian first gained a writing system, and a more recent one containing the ʻokina and kahakō letters (Kapali et al., 2025). Our system follows in the same vein as these systems, which were developed to meet the established needs of the Hawaiian community, but targets a different user base.

On the commercial side, Duolingo, a popular gamified language learning app, supports Hawaiian, but at a very introductory level. Recent changes to the app have introduced a system that limits the amount of exercises that can be completed without paying for the app or watching advertisements, which is prohibitive for language learners. Other commercial apps like Drops focus on vocabulary words, and apps like Kīpaepae and Hakalama, created by the ʻAha Pūnana Leo Hawaiian immersion schools, support common phrases and sentences, but are geared towards younger students and their parents. Our learning platform aims to aid both teaching and learning, with one of the main innovations being the use of context-free grammars to generate new, grammatically correct practice sentences for the student to translate.

3. System Overview

Our learning platform, Hōʻoi Aʻo, is accessible through a web browser and was designed for ease of use by both students and teachers of ʻŌlelo Hawaiʻi. In consultation with Hawaiian language instructors at the University of Hawai'i at Hilo, we prioritized specific features on our platform to address current pain points in both students' learning and teachers' instruction of the language.

3.1. Lessons and Vocabulary Lists

Our platform supports content organized by chapter, following the chapters of the Nā Kai ʻEwalu textbook. Within a chapter, students are able to browse lessons, which contain vocabulary lists, exercises, explanations, example sentences, grammar charts, and other additional material the instructor chooses to add. An example for Mokuna (Chapter) 3 is shown in Figure 1. Each chapter contains a vocabulary list, which includes new words, phrases, and example sentences used in the chapter. This vocabulary list is shown in a tabular format similar to how it is presented in the paper textbook, as seen in Figure 2.

3.2. Exercises

Gaining proficiency in a language requires constant practice, and exercises are the primary interactive method for students to practice using the language through our platform. We implement the translation-based exercises taken directly from the Nā Kai ʻEwalu textbook. Currently, there are exercises to translate Hawaiian to English, or translate English to Hawaiian, with plans to add other types of exercises (like multiple choice, fill in the blank) in the future. One recurring feedback from students about the textbook is that it does not include the answers to the exercises. Our platform contains the answers to these exercises and remedies the students' feedback: if the student answers incorrectly, a notification is displayed with the mistake underlined in red, providing immediate feedback to the student, as shown in Figure 3. The students can repeatedly complete the exercises as many times as they wish, as the students' responses are not scored or saved .

3.3. Quizzes

Quizzes are similar to exercises, with a key difference being that instructors can manually add questions, and the platform automatically stores and grades responses for each student. In the introductory Hawaiian classes, students typically complete a weekly vocabulary quiz on paper before reading the assigned chapter. This ensures that students have mastered the essential vocabulary required to understand the chapter's content. These vocabulary quizzes have a strict set of acceptable responses, so although they are straightforward to manually grade, instructors find this process tedious and provide little value in improving teacher-student interactions. Automatic grading was one of the instructors' most desired features for this platform.

Students are allowed to retake quizzes as many times as needed until they are satisfied with their score. After completing a quiz, students receive a summary of their correct and incorrect responses, and they can immediately retake the quiz when they are ready. When a student finishes a quiz, the

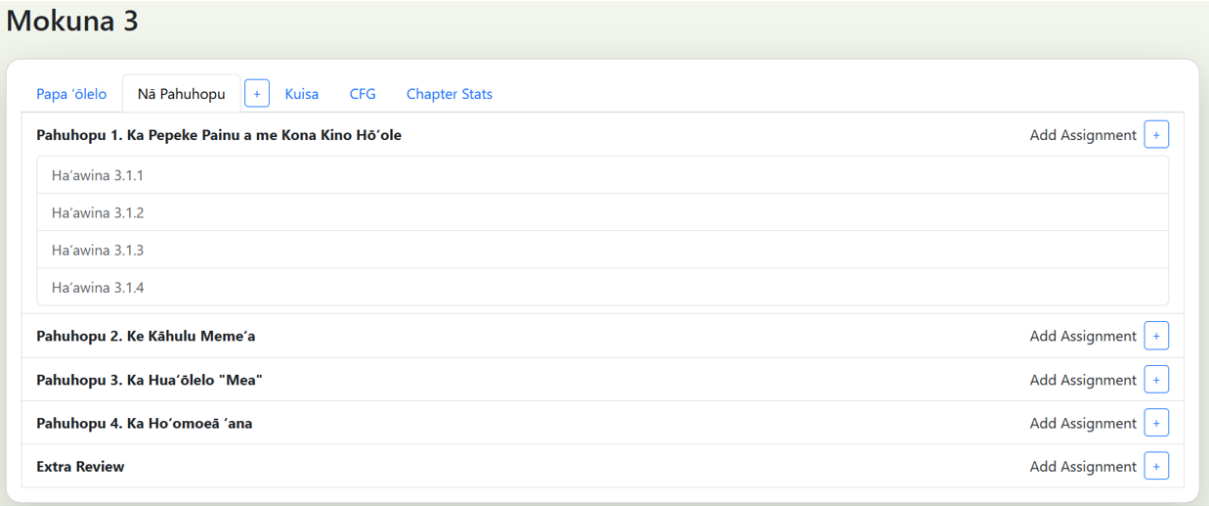

Figure 1: User interface display for chapter 3 content.

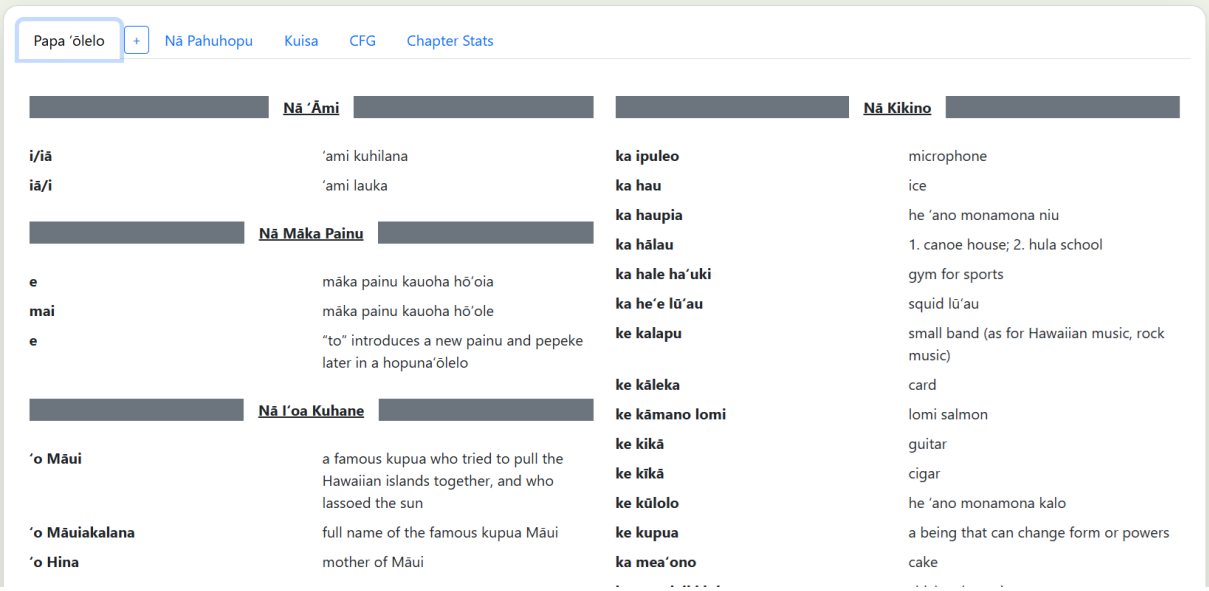

Figure 2: Vocabulary section from chapter 3

platform records a timestamp and stores their answers in a database. Submission data can then be downloaded by the instructors to discover where students are struggling, allowing the instructors to more effectively make use of in-person class time to tailor their instruction to the students' needs.

3.4. Context-Free Grammars

One innovation of our platform is the ability to generate additional practice sentences. Both students and teachers often remarked that the exercises from the textbook are not enough. Thus, teachers routinely create new practice questions for students to review, which takes up a lot of time. In addition, different teachers of the same section might have their own set of practice questions, which could lead to differences in students' learning.

Our platform generates additional translation exercises using synchronous context-free grammars (SCFGs). A context free grammar (CFG) contains a set of production rules of the form $A \rightarrow \alpha$, where the left hand side is a non-terminal symbol that can be expanded into the right hand side. A *synchronous* SCFG is a CFG where each rule is paired with its translation. This allows the SCFG to specify lexical translations for terminal symbols, and capture reordering between the two languages for non-terminal symbols. For example, consider the SCFG below (in NLP, the S symbol traditionally denotes the entire sentence):

S $\rightarrow$ Verb Subj Obj = Subj Verb Obj
Verb $\rightarrow$ ʻai = eat
Subj $\rightarrow$ au = I
Obj $\rightarrow$ i ka manako = the mango

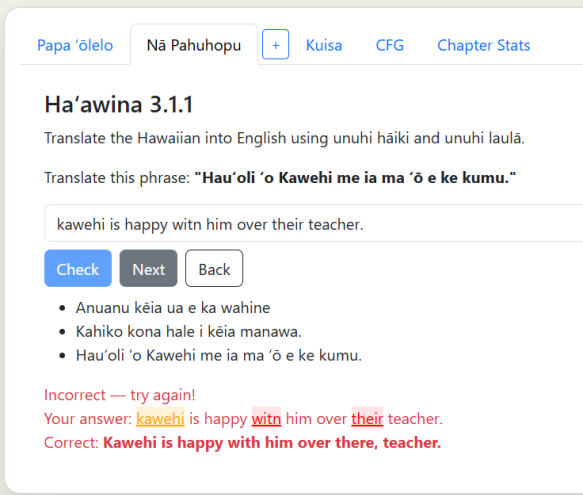

Figure 3: Feedback on a haʻawina (exercise) when a user answers the exercise incorrectly. The personalized feedback takes into account minor errors like capitalization, which are marked in yellow, while misspellings are errors marked in red.

This SCFG defines a typical Hawaiian sentence in VSO order (*ʻai au i ka manakō*) and its English translation *I eat the mango*. We see that the VSO is reordered as SVO in English. This type of formal grammar has been used in the past in syntax-based machine translation (Wu, 1997; Chiang, 2005), but its applications to language learning have not been thoroughly explored.

We use a standard recursive depth-first traversal algorithm to expand the non-terminal *S* to all possible sentences with their translations, with a small modification to handle cases where multiple non-terminals of the same part of pseech exist in a sentence. For example, consider the grammar below for a noun phrase consisting of two nouns with a conjunction:

NP -> N_1 a me N_2 = N_1 and N_2
N -> ka iʻa = the fish
N -> ke kakā = the duck

The generation algorithm considers the two nouns as N_1 and N_2 as different nouns and will not generate the translation pair *ka iʻa a me ke kakā* / *the duck and the fish*, which swaps the positions of N_1 and N_2 in the translation.

The platform comes preloaded with several SCFGs corresponding to the grammar and vocabulary of relevant chapters from Nā Kai ʻEwalu.

A slightly more complex SCFG is shown in the screenshot in Figure 4. This example uses the Hawaiian grammar system taught in Nā Kai ʻEwalu, sometimes called *pepeke grammar*, where the *poʻo* 'head' is the linguistic head of the sentence, the *piko* 'navel' is the main subject, and the *ʻawe* 'tentacle' is a phrase attached to head; this phrase is usually the direct object or a prepositional phrase.

Synchronous CFGs provide almost limitless possibilities for generating grammatically-correct practice sentences for students, so long as the grammar itself is correct. In this way, hundreds of sentences and their translations can be made with just a handful of SCFG rules, giving students ample opportunities to practice translating sentences not found in the textbook. These practice sentences are treated as an extra exercise that are automatically checked by our platform, and the platform has a page for instructors to modify the grammar rules.

Context free grammars for translation generation do have some limitations. Although in practice there can be many valid translations of a sentence, these exercises only allow a single admissible translation. This is fine for beginner-level Hawaiian language courses, where the goal of these exercises is to enable students to practice a limited set of grammar and vocabulary that were just learned in class. However, for more advanced students, a more flexible approach might be needed. In addition, SCFGs can generate sentences that are not semantically meaningful. For example, the grammar in Figure 4 can generate *akamai ka ua* 'the rain is smart'. The Hawaiian instructors actually found this phenomenon to be a feature rather than a bug: as the sentence is grammatically correct, it forces the students to think more carefully when practicing these exercises.

3.5. Additional Content

The platform supports slightly different interfaces for students and teachers depending on who is logging in. Teachers can add additional assignments, exercises, quizzes, and modify the context-free grammars for each chapter, which will be saved to the database. This gives faculty flexibility to add additional content that they see fit.

4. System Architecture

We implement Hōʻoi Aʻo using the FARM stack (FastAPI, React, MongoDB), a popular and flexible approach that allowed us to quickly iterate on our platform after receiving feedback from Hawaiian language professors.

4.0.1. Front-End

Since many Hawaiian teachers are of an older generation who may not be very tech-savvy, we strove to develop a user interface that was friendly and easy to navigate. The front-end was developed using React, a well-documented open-

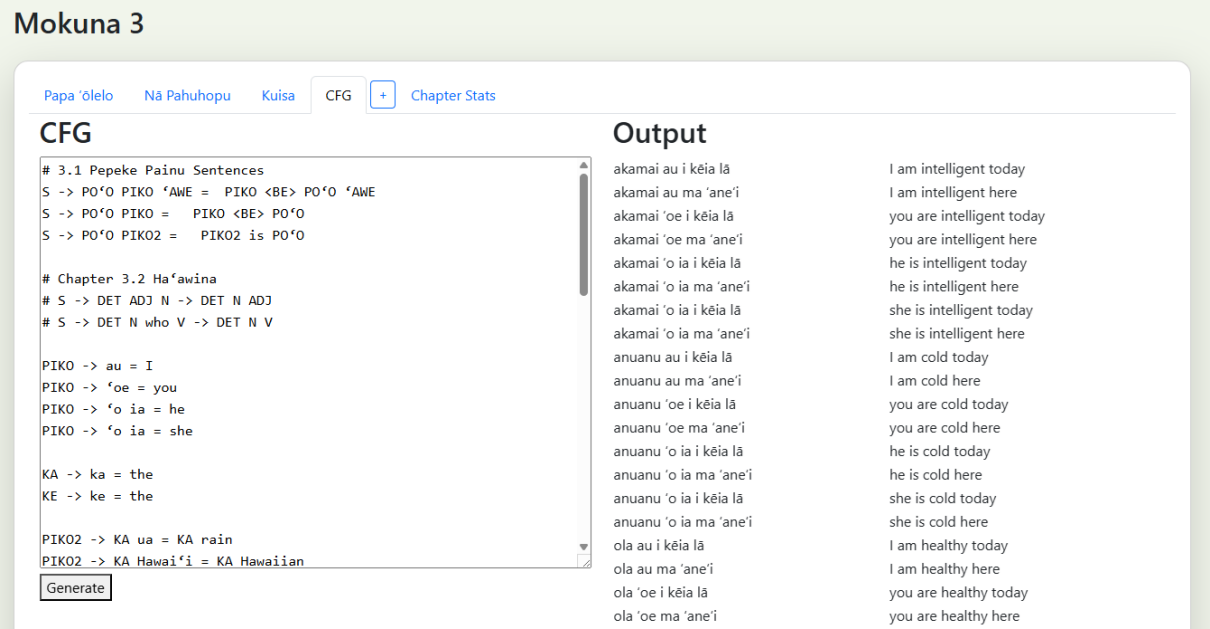

Figure 4: Screenshot of our platform, with the synchronous CFG on the left, and sentences generated using this grammar on the right. Our plaform can then randomly select from the generated sentences to create new exercises for students.

source JavaScript library for building user interfaces. React's component-based architecture enables developers to design modular, reusable building blocks that can be integrated throughout the platform's structure. This type of architecture allowed for better maintainability and expansion; components could be changed or updated without affecting other unrelated parts of the system.

Several key UI design decisions shaped the user experience of the platform. Rather than navigating to separate pages for each action, the platform utilizes modal dialogs for inputting questions and configuring settings. This approach keeps users in context, reducing the friction associated with page transitions and maintaining their focus on the current task. When users want to add a new question or modify parameters, a dialog overlay appears over the existing content, allowing them to complete the action and immediately see the results without losing their place in the workflow.

The quiz display interface was designed with clarity and engagement in mind. Questions are presented one at a time in a clean format that helps students concentrate on each item individually, rather than having all questions on one page, since the professors felt that seeing all the questions could give the students extra hints. Progress indicators show students how far the students advanced through the quiz, while immediate visual feedback confirms their selections. After submission, results are displayed with clear color coding. Correct answers are highlighted in green and incorrect ones in red, making it easy for students to review their performance and understand areas requiring improvement.

4.0.2. Back-End

We used the web framework FastAPI to develop the back-end, due to its high performance and support for asynchronous operations (Tiangolo, n.d.). This framework provides a RESTful API that allows for communication between the React front-end and the server. The back-end structure consists of modular python files, each holding specific component of the FastAPI application. Core files consist of MongoDB connections, data schema, routs, and endpoints for defining API logic.

For our database, we use MongoDB, which was chosen for its familiarity and flexible document model, which can store various types of language content such as chapters, quizzes, and user information. MongoDB supports a dynamic schema which is ideal for class content such as lesson quizzes, assignments, practice work, and vocabulary, where different objects have different structure. Indices were created for each collection in the database, allowing for efficient lookups that involve multiple collections.

5. Discussion

Hōʻoi Aʻo is designed to support both instructors and students at the University of Hawaiʻi at Hilo in the teaching and learning of ʻŌlelo Hawaiʻi. Students can access their course materials online, al-

lowing them to read and review chapters, complete practice exercises, and strengthen their understanding of the language at their own pace. Teachers, in turn, can add content to facilitate students' learning, view assignment submissions, collect and analyze grading data across their courses, and identify areas where students are struggling. These insights enable instructors to refine their materials and develop more effective, targeted content for classroom instruction.

We are planning to integrate Hōʻoi Aʻo into introductory Hawaiian classes starting Summer 2026. We will conduct training sessions for students and teachers to get acquainted with the platform. Additionally, we plan to train teachers to write their own context-free grammars. Once integrated, we plan to listen closely to any feedback students and teachers may have, and implement features that they deem helpful. Some other features that are under discussion for implementation include flashcards and a personalized scheduling algorithm to optimize students' learning. We believe that our platform can revolutionize language learning in the classroom, especially for indigenous languages with few existing learning resources. Rule-based approaches like context-free grammars can quickly provide practice materials when textbook exercises are not enough. We would also be interested in deploying our platform to other schools across Hawaiʻi, and potentially developing a generalized version to support the revitalization and learning of other indigenous languages.

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