

# A Web App for Teaching Piano to Students with Autism

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## ABSTRACT

This work aims to promote musical learning in order to ease the inclusion of students with autism in the classroom and during musical performances. To this end, a web application was developed using a user-centered design approach involving professionals experienced in training people with autism, to help end users learn the basic concepts of music. The app allows teachers or caregivers to set up a customized learning environment according to each student's needs, so that these students can play songs in collaboration with classmates. Preliminary results suggest a key role for technology in facilitating music teaching and in supporting the learning process for students with autism.

## CCS CONCEPTS

•Human-centered computing~Human computer interaction (HCI)~Interaction paradigms •Social and professional topics~User characteristics~People with disabilities

## KEYWORDS

Accessibility, Usability, Web applications, Music, Autism

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## 1 Introduction

Music therapy benefits students with autism, including low-functioning individuals, by positively influencing communication, socialization and behavior [2-6]. However, such students can experience difficulty in classic learning environments, since their attention may be impaired and their perception (especially auditory and tactile) is prone to distraction, compared to neuro-typical students, making it difficult to concentrate without assistive visual elements and cues [1], [9]. Structured learning offers students with autism a repeatable, predictable and coherent training environment,

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which reduces anxiety and facilitates mastering skills. For these reasons, we believe that a structured and accessible web app designed for teaching music to students with autism is an approach worth exploring.

## 2 The Application

The design team included computer scientists, a psychologist, and special needs and music teachers. The team identified the need for two different environments: one for the student to learn basic music concepts in an accessible and structured way, with increasing levels of difficulty; the other for the teacher/caregiver to configure the student's space and monitor their progress over time.

An initial version of the app was tested on seven students with autism and showed some usability issues, especially regarding reactivity of the augmentative elements of the graphic user interface (GUI) [10]. These issues led to a complete redesign of the app by splitting it into two: a back-end, developed in Ruby on Rails and PostgreSQL; and a front-end, a single page application using the framework Ember. In this version the activities provided to students are (Fig.1):

1. **Lessons:** to learn Notes, Note value (relative duration) and Circles (harmonic turns, i.e., the notes of a chord)
2. **Leisure:** to play on a customizable virtual piano keyboard, choosing the sounds from among the instruments piano, clarinet or xylophone (Fig. 2)
3. **Executions:** to play a musical score with classmates (still in progress).



Figure 1. Activities

The Lessons activity provides three learning programs for training on Notes, Note values and Circles. The user interface of the learning programs is composed of two sections: the virtual piano keyboard at the bottom and a dynamic section at the top, including the trial's discriminative stimulus (what to do) and the feedback (a grey neutral emoticon that changes into a green smile when the trial is executed correctly or a red sad emoticon in case of error). The discriminative stimulus includes a pentagram and the

note label. In this way it is easier to associate the note label with the target key on the virtual piano keyboard (favoring the learning of the musical notation). The principle is to progressively fade out these augmentative items, allowing the students to still interpret a musical score, thus generalizing the learning process. To avoid errors (errorless learning has proved to be highly effective [7]), only the target key is enabled to be played, while others do not produce any sound.



Figure 2. Leisure Activity

The learning programs offer a configurable environment, to better adapt the individual’s characteristics. Possible customizations are related to a) visual elements of the user interface, e.g., selecting the working octaves (left, central, rights or a combination of them), coloring the keyboard or not, etc.; or b) the learning exercises, e.g., setting the number of trial repetitions in case of errors, proposing ordered or random sequence of trials, using a diatonic or a chromatic scale, etc.



Figure 3. Note Value Program – Play F for 4/4, successful

The learning programs have augmentative elements to make the environment more accessible for the end users (adolescents with autism). Some of these are common to all programs, such as the feedback element provided through a smile emoticon or the colored keyboard. Other elements are only relevant for a specific program. The Note Value program enriches the GUI with a 4-unit progressive bar (corresponding to a 4/4 duration) that is filled according to the length of time the key is pressed to help students better understand when the note value is reached and thus remove their finger. In addition, it is possible to enable (or disable) a metronome to mark the tempo (Fig. 3).

The Circle program teaches the execution of a sequence of 4 notes; notes played become semitransparent to highlight the elements of the sequence still to be played.

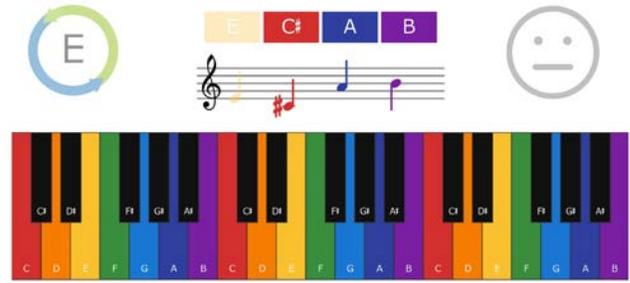


Figure 4. User interface of the Circle learning program

The teacher user interface allows teachers to set up their didactic plan, activating the most suitable learning programs and customizing them according to the user’s need.

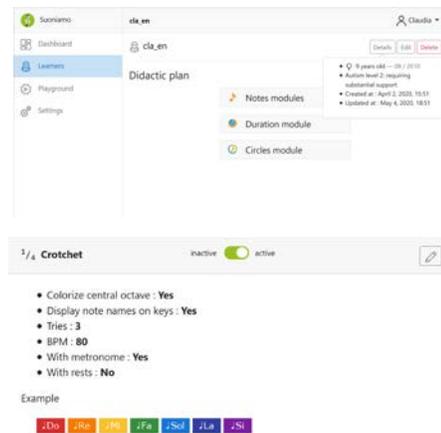


Figure 5. Teacher user interfaces – setting up a learning program

### 3 Preliminary test and results

The app was tested on students with autism at two different stages of the development cycle to observe user interaction and collect early feedback for its improvement [8]. After the preliminary test mentioned above, we tested the new version of the learning programs on 10 adolescents with autism who had never tried the app before, in order to test the intuitiveness of the interfaces and evaluate the value of the augmentative visual items. All users showed an immediate understanding of the proposed trials when performing the Note program, while for 30% of users prompting was necessary when executing the Note Value program. Augmented elements of the user interface were generally useful, except the metronome, which was not tolerated by some participants (due to auditory disturbance) but which could be directly disabled by users. A larger user test is scheduled for the next academic year to investigate the actual efficacy of the app in terms of learning support.

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