Proximal
Early Education Learning Management System

by
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Abstract

Parental involvement is the most significant factor contributing to the academic achievement of children in Early Education (Desforges, 2002). Proximal promotes parental involvement by providing high quality responses to two important questions: “How is my child doing?” and “What can I do to help?” Proximal answers the question, “How is my child doing?” by measuring learning progress over time through a series of formative assessments benchmarked to learning objectives defined in the Common Core State Standards (National Governors Association, 2012). The Zone of Proximal Development is a concept in the study of Education which describes the set of skills a student has yet to achieve, but is ready to develop if given help. Proximal answers the question, “What can I do to help?” by putting the concept of the Zone of Proximal Development into practice. Proximal analyzes formative assessment results and dynamically generates sets of learning activities which the child can perform with a parent.

Introduction

Children who receive help at home learn more in school (Blanden, 2007). Parents who provide help need information about the academic progress of their children in order to provide effective help. Parents often struggle to get detailed information from teachers and schools about the academic progress of their children (Sanders, 2008). The traditional grading system provides information only at the end of a grading period and only in the form of a single letter or number. Letter grades give parents a summary of progress, not the detailed information parents need to know how to help. Proximal gives parents the information they need to understand the current academic progress of their children and to know where they can most effectively be of help.

Problem Statement

The primary challenge in supporting the academic progress of a child in early education is knowing what to work on next (Yaffe, 2009). Traditional educational design solves this problem by developing state standards, curricula, lesson plans, and assignments. This traditional approach to learning design has proven effective for students whose learning progress has matched the pace of instruction given by the teacher. This same approach has delivered less effective results for children who have learned more quickly or slowly than the pace of instruction given by the teacher.

The Zone of Proximal Development (ZPD) is a concept in the study of education which describes the set of tasks a student can complete if given help from a "more knowledgeable other" (Cole, 1978). Outside the ZPD are learning activities which are too easy or too difficult. Working on a task which is too easy fosters boredom, instead of learning. Working on a task which is too difficult fosters anxiety and frustration, instead of learning.

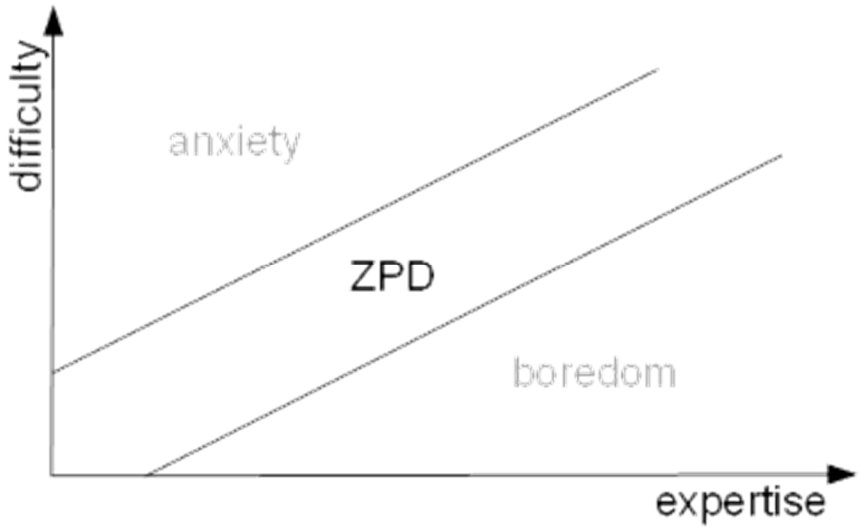

Figure 1. Zone of Proximal Development

Solution

Proximal gives parents the information they need to provide effective academic help to their children by gathering information about the child's current skill set and suggesting learning activities targeted to the child's Zone of Proximal Development. Proximal regularly presents questions to the parent and asks the parent to score responses made by the child. Proximal uses the scores of each answer to build and continually refine a learning profile for the child. Proximal applies predictive analytics to the data in the learning profile and generates a list of recommended learning activities for the parent to share with the child.

Each question and learning activity provided by Proximal is cross-referenced to a learning objective expressed in the Common Core State Standards. The relationship established between these learning objectives and the learning activities provided by Proximal enables the system to provide parents with accurate, up-to-date information about the academic progress of their children and measure the pace at which the child is learning.

Technical Elements

The technical elements of the system are comprised of four primary subsystems: the Web Service, the Web Application, the Mobile Application, and the Analytics Engine.

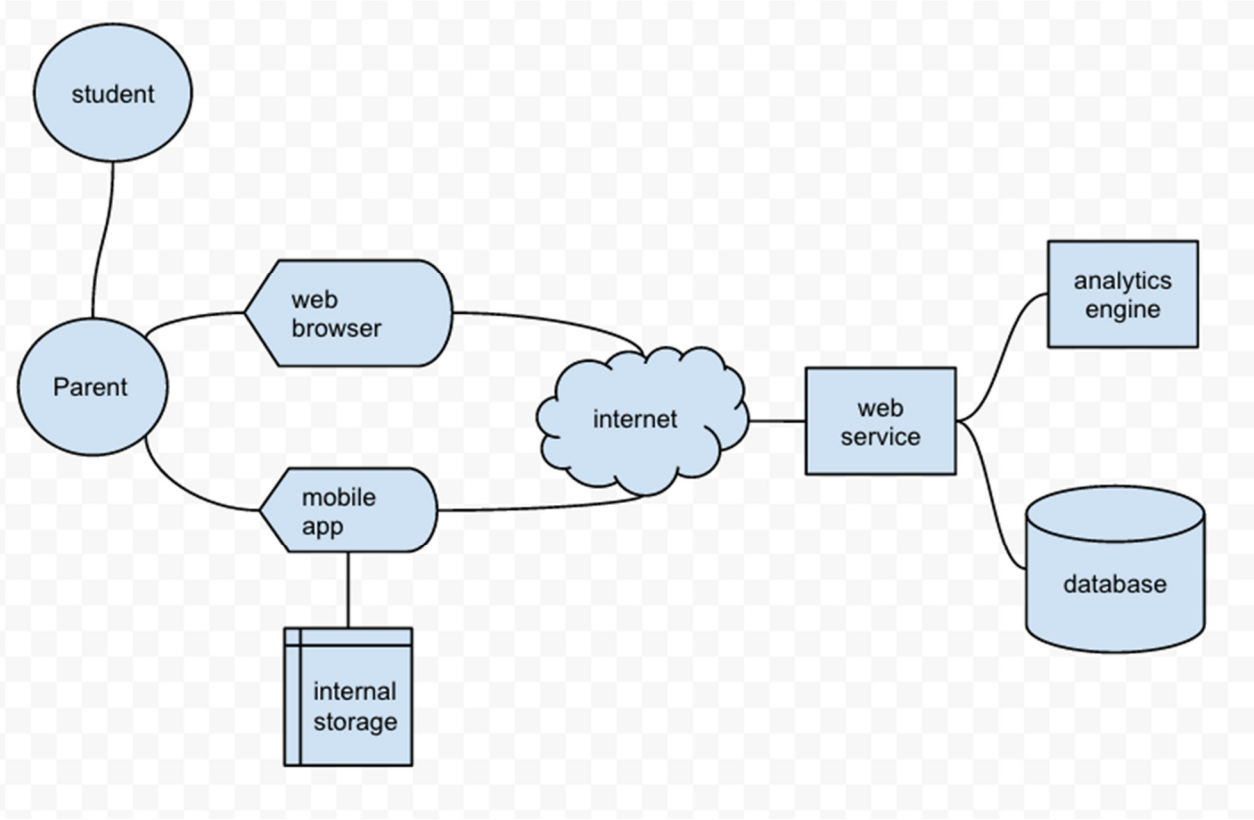

Figure 2. Technical Elements

Web Service

The web service is developed as a RESTful (Fielding, 2000) service making use of the built in HTTP verbs, GET, POST, PUT, DELETE. It is implemented using Scala with the Play Framework which provides out-of-the-box support for Javascript Object Notation (JSON) which is essential to RESTful design. The web service is the central point of communication to access the backend PostgreSQL database by the Mobile application and the web application. The web service is secured using an email address and a hashed password or using OAUTH 2 with the users Google or Facebook password.

Web Application

The web application is built with standard HTML 5 and CSS 3 technology using Bootstrap, a toolkit that focuses on responsive and mobile-first design. AngularJS was chosen as the Javascript framework because of its ability to create small reusable modules. Angular also provides two-way data-binding which decreased the amount of code we needed to write.

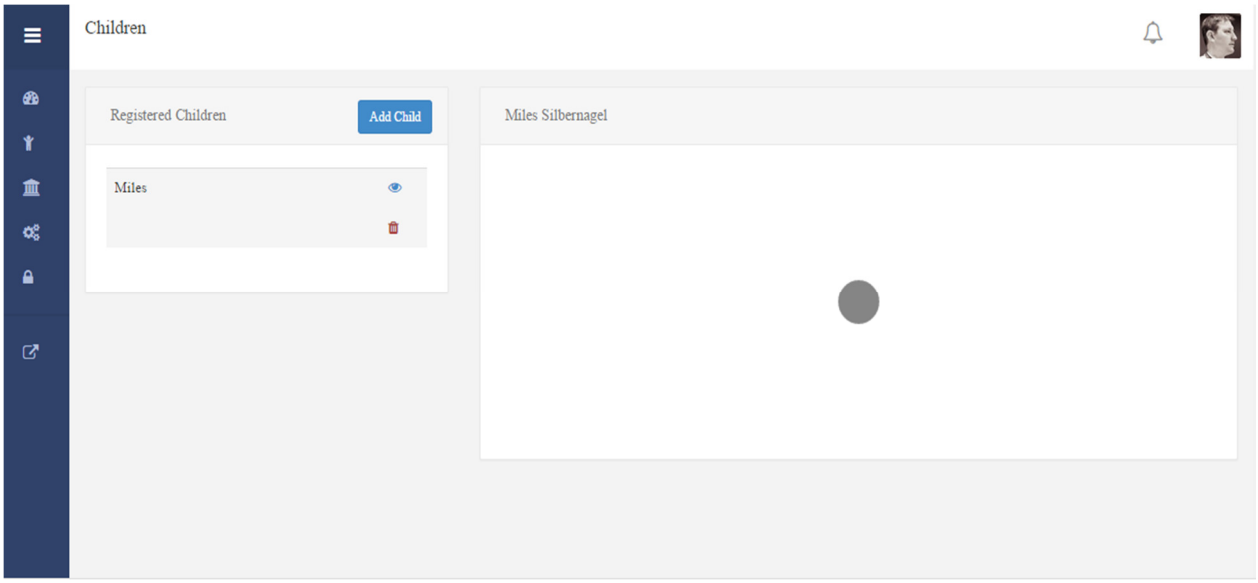

Figure 3 - Web Application

Mobile Application

The mobile application is built for the Android platform. It makes heavy use of the web service using the Apache HTTP Client library. To make the mobile app more efficient we used a SQLite database to cache data. This method allows for the parent or teacher to continue using the app even when they have been disconnected from the network. Plans for an IOS version of the application will be initiated subsequent to stabilization of the initial Android release.

Figure 4 - Mobile Application

Prediction Algorithm

The predictive algorithm we use to suggest sets of learning activities builds upon the simple interaction model used in the mobile application. When a parent is presented with a question by the application, the parent scores the response given by the child using one of four categories: Pass, Don't Know, Incorrect, or Correct. The predictive algorithm converts each of these responses into the numeric values 0, 1, 2, and 3, respectively. The score of the response is added to previous responses, cross-referenced with the learning objectives related to the question, and averaged within each set of learning objectives defined in the Common Core State Standards. If the average score of responses to questions related to a learning objective is nearest to 1, then the next following question will be selected from the body of questions related to a lower-ordered learning objective. If the average grade is nearest to 2, the following question will be selected from the body of questions related to the same learning objective. If the average grade is nearest to 3, the following question will be selected from a higher-ordered learning objective. The application persists a record after each calculation of average scores. This record serves as a marker for the algorithm upon each successive execution.

Use Case Diagram

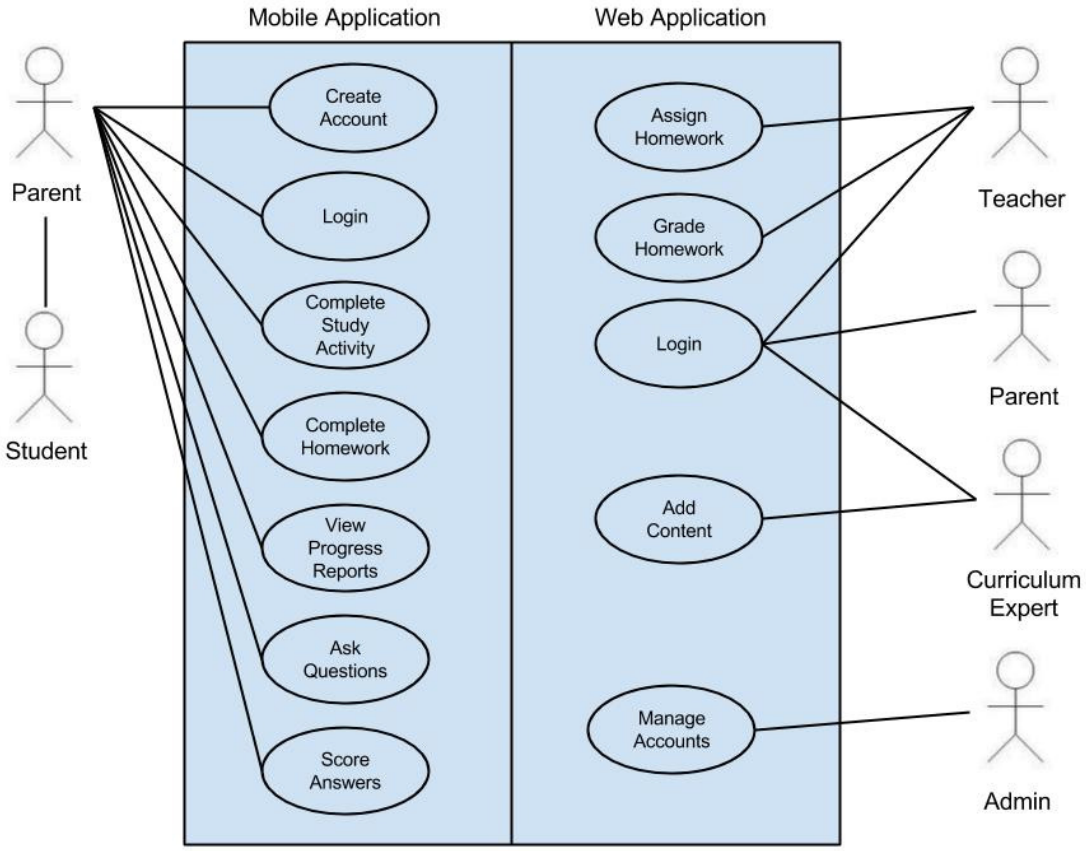

Figure 5 - Use Case Diagram

User Profiles

Potential Users:

- Parents
- Students
- Curriculum Experts

Software and Interface Experience:

- Parents
    - Parents who use the mobile application will require sufficient experience to allow them to find the application in the app store and install the application on their mobile device. Parents who use the web application will need sufficient experience to allow them to navigate to the website using a standard browser, like Google Chrome, Mozilla Firefox, or Microsoft Internet Explorer.
- Students
    - Proximal is designed primarily for parents to use in interacting with their children. Children should have minimal interaction with the mobile application or web application.
- Curriculum Experts
    - Curriculum experts should have sufficient skills to use any contemporary web-based application. The user experience for curriculum experts is designed primarily for the web application, not the mobile application.

Experience with Similar Applications:

- Parents
    - Parents with a mobile device or personal computer will have experience using similar applications because Proximal has been developed using contemporary web and mobile UI standards.

- Curriculum Experts
    - Curriculum experts will have experience using similar web applications to create, read, and update learning content, such as Blackboard and Moodle.

Task Experience:

- Parents
    - Parents should have some experience working with their children on learning activities, like homework assignments and informal skills assessment questions, prior to using Proximal.
- Curriculum Specialists
    - Curriculum experts have a professional background in creating and evaluating educational content.

Frequency of Use:

- Proximal is designed for parents to use once a day for approximately 30 minutes. Parents may choose to use the application as often as they like.
- Curriculum Experts may use the web application to review and create a single item of content upon request, or in the context of a project managing a larger collection of content. The frequency of use in either context may vary.

Key Interface Design Requirements that the Profile Suggests:

- Simple and intuitive interface that can be used by novice computer users.
- Make use of both mobile and web interfaces.
- The web service needs to be timely in response to requests from the web application or mobile application to provide the best user experience.

Delivery

The Agile project management methodology was used in the delivery of this system (Alliance, 2001). Each phase of the project was planned to produce a "shippable" product on completion. The iterative development and feedback process informed the design of the system from each phase to the next.

Timeline

The high-level project plan included start-to-finish dependencies at the beginning of each phase upon the previous phase.

	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**Concept**	10 days	Mon 9/1/14	Fri 9/12/14	
2		**Design**	15 days	Mon 9/15/14	Fri 10/3/14	1
3		**Build**	**120 days**	**Mon 10/6/14**	**Fri 3/20/15**	
4		Iteration 1	25 days	Mon 10/6/14	Fri 11/7/14	2
5		Iteration 2	25 days	Mon 11/17/14	Fri 12/19/14	4FS+5 days
6		Iteration 3	25 days	Mon 1/5/15	Fri 2/6/15	5FS+10 days
7		Iteration 4	25 days	Mon 2/16/15	Fri 3/20/15	6FS+5 days
8		**Test**	15 days	Mon 3/23/15	Fri 4/10/15	7
9		Release	1 day	Tue 4/14/15	Tue 4/14/15	

Table 1 – Gantt Chart

Budget

The budget for this project was limited to basic expenses for hosting and domain name registration. The software used to develop the web and mobile applications was free (Stallman, 1985).

Item	Cost
Domain name registration	$30
Web hosting service	$50
Android Studio IDE	$0
Vim Text Editor	$0

Table 2 – Budget

Conclusion

The system we developed provides parents with targeted information they can use to support the academic growth and development of their children. This system uses an interaction model designed to fit the typical pattern of conversation between parents and children. The information solicited through formative assessments is cross-referenced with learning objectives defined in the Common Core State Standards. Cross-referencing formative assessment information with standardized learning objectives allows the system to provide parents with accurate and useful information about the academic progress of their children. By emphasizing the role of parents in the education of their children, and by providing parents with tools and information to help them be effective partners in the education process, Proximal broadens the availability of high-quality education.

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