Lab 2 – Inclusive Classroom Product Specification

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Table of Contents

Listing of Figures

Listing of Tables

1 Introduction

Beginning in April 2020, school systems have been forced to adapt to new teaching styles due to the COVID-19 pandemic. Young, underprivileged students have been the most adversely affected by the switch to online learning due to the lack of technical skills and support at home when the Internet fails and lack of a stable, high-speed Internet connection. As students turn to their parents for assistance, parents are facing troubleshooting difficulties of their own. While parents turn to teachers for technical assistance, teachers are lacking the technical skills to solve the issues that arise in their virtual classrooms. Approximately 40% of students from low-income homes rely on overloaded, time limited public internet connections to complete their assignments (Vogels, 2020). Young students are fully reliant on their parent or guardian's schedule to find an available public connection. The overwhelming process for students, parents, and teachers to complete assignments and live stream classes can best be explained by the current Assignment Process Flow and Live Video Process Flow in Figure 1 and Figure 2, respectively.
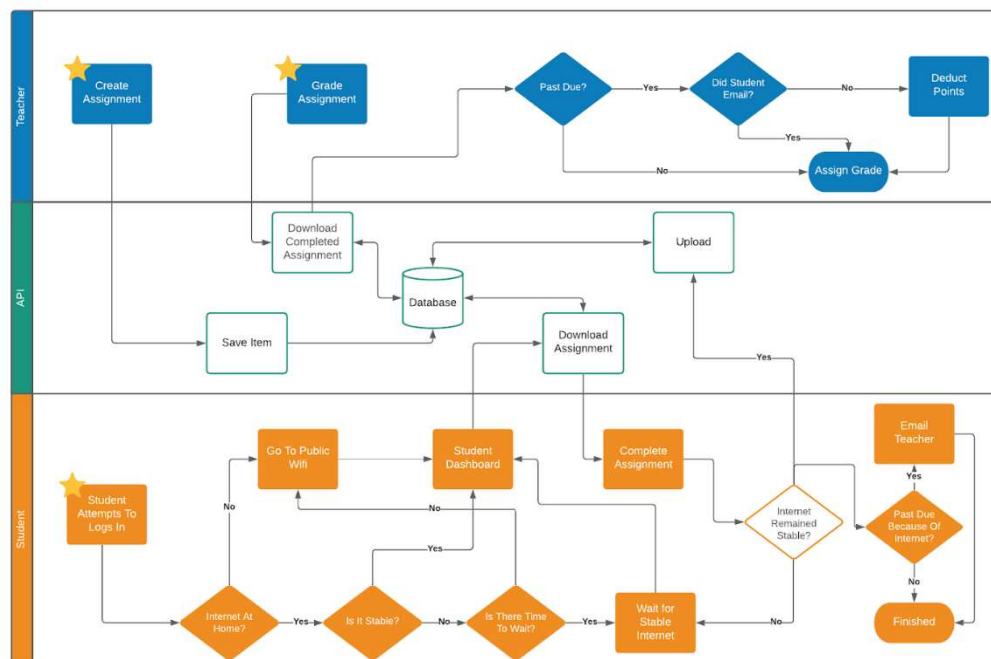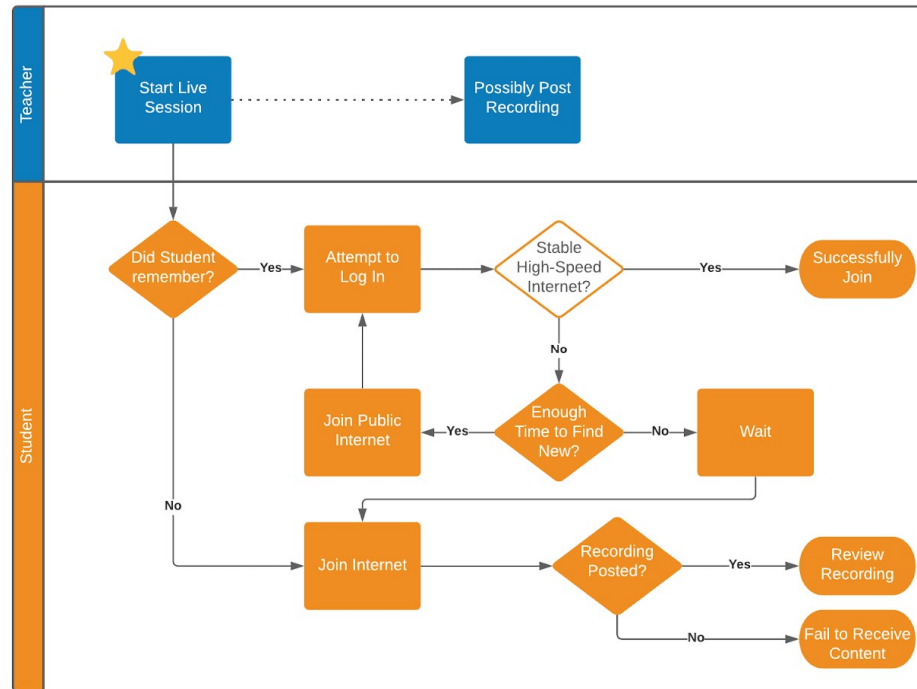

Figure 1: Assignment Process Flow

Figure 2: Live Video Process Flow

1.1 Purpose

Inclusive Classroom will be a native application that will consist of a simple UI on the student facing side that will be easy for children to use and a teacher or administrator facing side. To mitigate the lack of technical skills in students, parents, and teachers, Inclusive Classroom will have a high level of automation for processes such as uploading, downloading, zipping, and unzipping files. Since teachers and administrators will likely have access to stable internet within their school, the teacher view of Inclusive Classroom will not be constrained to a certain device type and will only require a login and password for access. Inclusive Classroom will focus on convention over configuration to maintain simplicity for student users. Inclusive Classroom will target all school systems across the United States as prospective users. The IC software will support Chromebooks and the three main operating systems, Windows, Mac OS, and Linux, to ensure accessibility.

Using a two-pronged approach, Inclusive Classroom will increase the accessibility of online learning for low-income students. While the Inclusive Classroom software must be installed with an internet connection, students will be able to view lectures and complete assignments without the internet. Inclusive classroom will provide students the ability to passively download assignments and lectures and upload assignments with a timestamp attached to enable teachers to determine whether an assignment was completed on time. The IC software will manage lectures, assignments, and submissions to keep students on track for the school year. While students will be able to complete an entire year of coursework without the internet, IC will require students to connect to the internet at the end of the school year for their profile to automatically synchronize with the server and complete their coursework submission. With Inclusive Classroom, students with continuously or intermittently stable internet connections will be able to automatically synchronize with the server for assignment submissions and attend live lectures when possible.

To accommodate teachers and avoid degradation in learning, Inclusive Classroom will provide a range of tools to keep teachers in control of their classrooms both synchronously and asynchronously. Inclusive Classroom will allow teachers to plan an entire school year of lectures, assignments, quizzes, and tests, set due dates, and select a pace for students to follow to ensure timely completion of materials. Once IC software is installed on student devices, Inclusive Classroom will automatically load and manage all the lesson plans provided by the teacher. If a teacher is unable to preplan their entire school year, Inclusive Classroom will provide teachers the ability to add assignments and lectures on a weekly basis to ensure students with intermittent internet access still receive their coursework. By accommodating both teachers

and students, Inclusive Classroom will promote an effective and efficient learning process, as detailed in Figure 3.
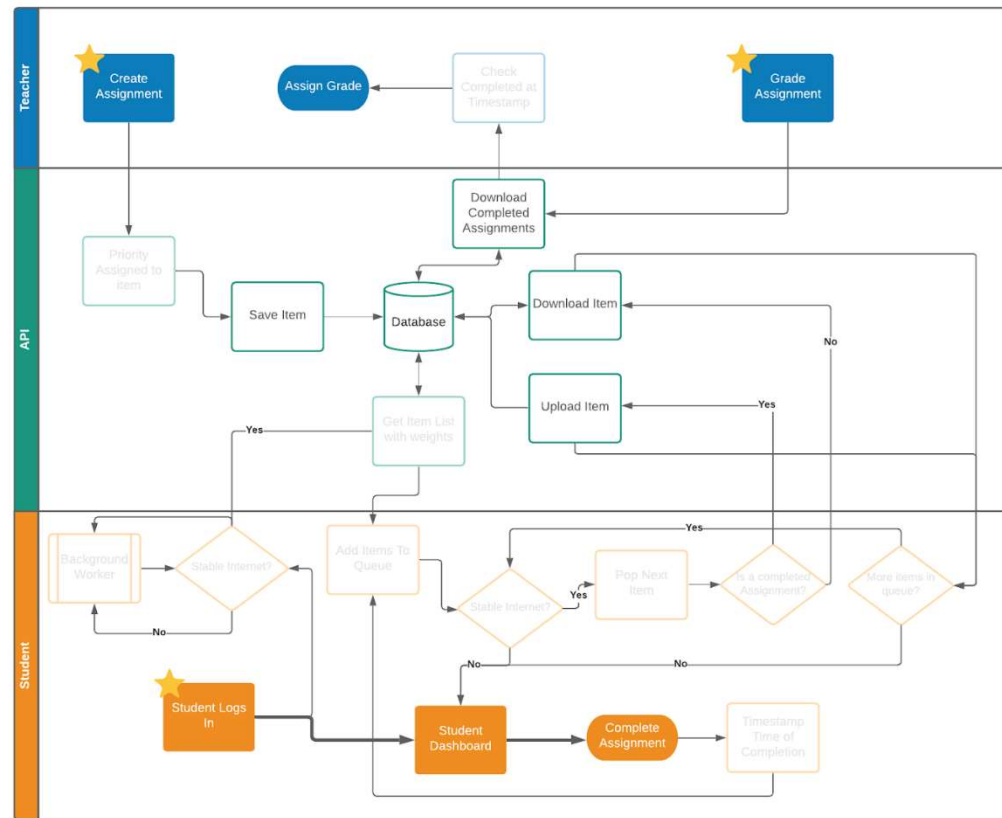

Figure 3: Inclusive Classroom Solution Process Flow

1.2 Scope

Inclusive Classroom will be designed for students and teachers across the United States, especially those suffering from a lack of stable internet and a lack of technical skills. IC will allow students to complete assignments and view lectures offline to avoid degradation of their learning experience. IC will allow teachers to control and maintain their classes for synchronous and asynchronous learners to avoid spending time troubleshooting issues rather than teaching. Inclusive Classroom will automate file uploads and downloads, data management, and timelines to remove the burden from teachers and students, allowing them to focus on education rather than software functionality. Inclusive Classroom will allow students and teachers to participate

in an effective learning environment despite the challenges of virtual learning, such as access to continuous stable internet and adequate technical skills to use various software.

The prototype for Inclusive Classroom will be a native application that demonstrates the key features of the software. The Inclusive Classroom prototype will need to be presented at the end of Old Dominion University's Fall 2021 semester. Due to time constraints and limited experience with development tools, such as React Native and JavaScript, the functionality of these features will be limited in comparison with the real-world product version of Inclusive Classroom. The most critical roles in Inclusive Classroom are student and teacher. For this reason, a majority of the prototype will be dedicated to demonstrating the capabilities of these roles, such as assignment creation, assignment submission, and lecture videos. The prototype of Inclusive Classroom will demonstrate the limited functionality of the school administrator role, where a school administrator will have the ability to view information about students and teachers, evaluate a teacher's performance, and view a student's academic progress. The prototype will not include a demonstration of the Information Technology specialist role, due to the required functionality of such a role and the inability to implement the requirements by the prototype deadline. While the Inclusive Classroom prototype will not have the same level of functionality as the real-world product, the prototype will demonstrate the software's usefulness for students, teachers, and administrators in school systems across the United States.

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1.3 Definitions, Acronyms, and Abbreviations

ESL - English as a Second Language

Family Educational Rights and Privacy Act (FERPA) - Federal law that protects the privacy

> of student education records

Google Classroom - "Free web service developed by Google for schools that aims to simplify

> creating, distributing, and grading assignments" (Google)

High-speed Internet - Internet with consistent download speeds of at least 3.8 Mbps (Zoom)

HTTP – Hypertext Transfer Protocol

IC - Inclusive Classroom

littleLearners - Former CS 410 group solution that emphasizes simple UI for students in the K-5

> age range (Del Razo)

ORM – Object-relational mapping; programming technique for converting data between

> incompatible type systems

RFC – Request for Comments; a formal document from the Internet Engineering Task Force

Stable Internet - Internet with less than 1% dropped packets (ICTP)

UI - User Interface

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    Homework Because of the Digital Divide." Pew Research Center, Pew Research Center,

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their-child-may-face-digital-obstacles-in-schoolwork/.

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1.5 Overview

This product specification provides the hardware and software components, external

interfaces, capabilities, and features of the Inclusive Classroom prototype. The remaining

information provided in this document includes a detailed description of the architecture and

features of Inclusive Classroom. The information provided on Inclusive Classroom's prototype

features will include the parameters used to control, manage, and establish each feature and the

performance of each feature in terms of outputs, displays, and user interaction.

2 General Description

Inclusive Classroom will be designed to mitigate the current issues with virtual learning

affecting students and teachers. As a native application, Inclusive Classroom will prevent under-

privileged students from having to regularly access the internet to receive a quality education.

Students will be able to view and submit assignments, view lectures, and follow the pace of a

class all without internet connection. Teachers will be able to upload lesson plans, determine the

class timeline for students to follow, record and upload lectures, and create and grade

assignments. A school administrator will be able to view all students and teachers, evaluate a

teacher's performance, and view individual students' academic progress to identify students that

may be struggling in school. Through the implementation of such features, students, teachers,

and administrators will be able to focus on education rather than resolving technical issues.

2.1 Prototype Architecture Description

The Inclusive Classroom prototype architecture will have many of the same features as the

real-world product architecture. The client application will be a React Native application

primarily written in JavaScript. The Inclusive Classroom client application will use an SQLite

Database to store lectures, assignments, and class information. Actions performed in the

Inclusive Classroom application are initiated by users and will depend on accessing the SQLite

Database. In the Inclusive Classroom prototype, the client application will communicate directly

with the REST API using Node.js and Express.js. The API will communicate with the server-

side PostgreSQL Database where videos and assignments will be saved, assignments will be

place in a priority queue, and user account data is stored. The relationship between the various

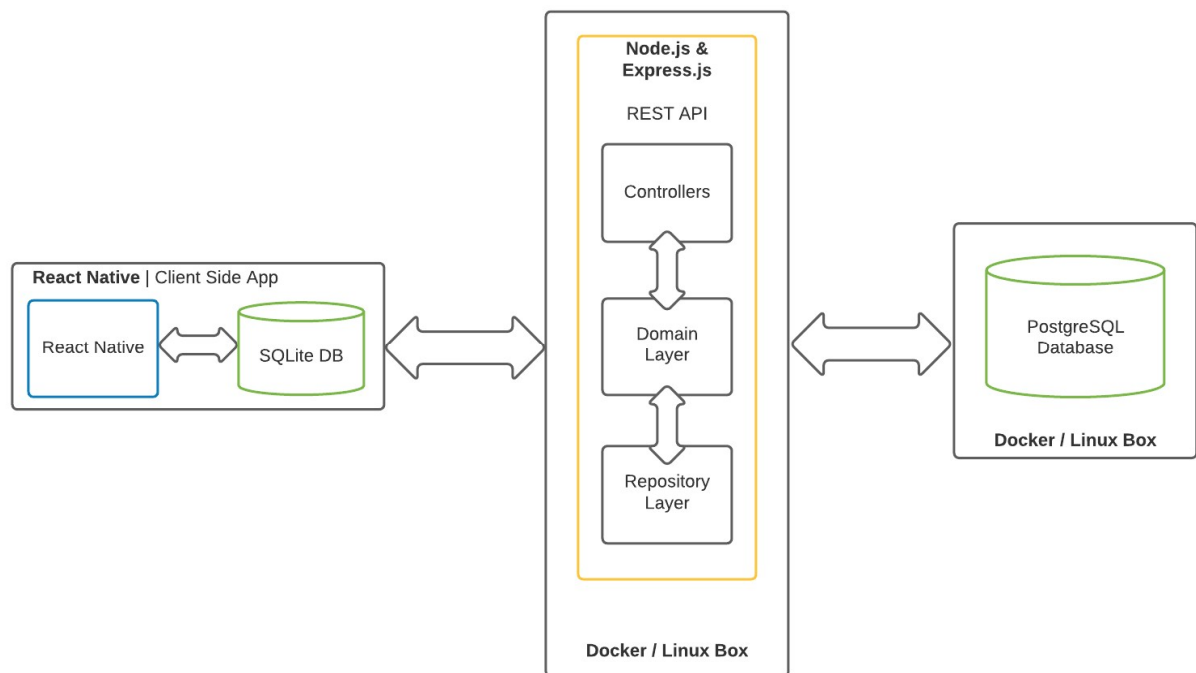components of Inclusive Classroom is detailed in Figure 4.

Figure 4: Inclusive Classroom Prototype Major Functional Component Diagram

While the Inclusive Classroom prototype will utilize many of the same components as the

real-world product, the prototype does vary from the real-world application. In the Inclusive

Classroom real-world product, the client application will not communicate directly with the

SQLite Database. Instead, the client application will communicate with an external API that

sends and receives data from a Redis data structure store, which functions as a key-value

database, cache, and message broker. The Redis cache layer will communicate with the REST

API to access the server-side PostgreSQL database. Inclusive Classroom's real-world major

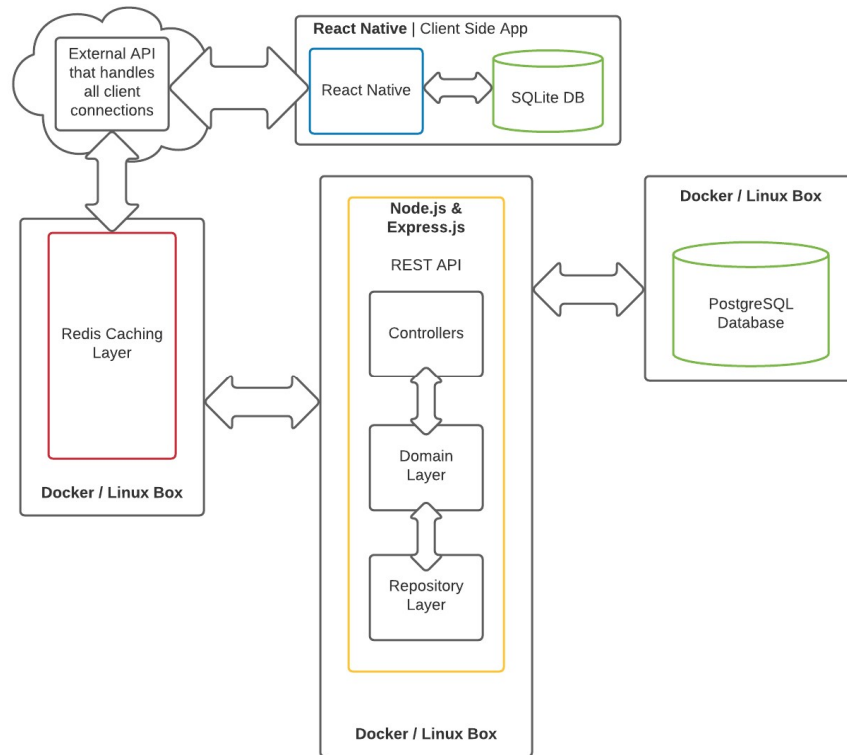functional components are further detailed in Figure 5.

Figure 5: Inclusive Classroom Real-World Product Major Functional Component Diagram

2.2 Prototype Functional Description

The Inclusive Classroom prototype must first be accessible to users on a Windows 10,

Mac, or Chromebook device. An internet connection will be required for users accessing

Inclusive Classroom for the first time. After ensuring the application is accessible, a user will be

prompted to create an account or log into an account. Inclusive Classroom will use

authentication to ensure the application is secure and user information is protected. After

successfully logging into their account, the user's dashboard view will depend on their user type.

For students, the dashboard will consist of a simple UI displaying current assignments and links

to video lectures. For teachers, the dashboard will consist of links to create assignments, grading,

and starting video lectures. For administrators, the dashboard will consist of links to view all

students and teachers, evaluate a teacher's performance, view information about a specific class,

and view information about an individual student's academic progress. Inclusive Classroom will

include a web conference page for all users to meet in a private setting to discuss personal

matters. Inclusive Classroom will utilize automation to mitigate the lack of technical skills

amongst users. Inclusive Classroom will feature a weighted priority queue for downloading

assignments, automatic detection of the Internet, and automatic submission of assignments when

internet access is detected. These features of Inclusive Classroom will ensure that users

regardless of their access to internet or technical skill level can participate in a meaningful

learning experience.

The Inclusive Classroom prototype will exhibit many of the critical features of the real-

world product. The major differences between the prototype and the real-world product will be

the absence of an Information Technology specialist role and limited functionality of certain

features, such as creating any type of assignment, postdating created content, auto-recording

lectures, and reporting. The differences are largely attributed to the lack of time, skills, and

personnel required to implement these features. For a list of the features included in the Inclusive

Classroom real-world product and prototype and a better understanding of their similarities and

differences, refer to Table 1.

Feature	RWP	Prototype
Account Roles	Student, Parent, Teacher, Admin, IT	Student, Teacher, Administrator(limited) only
Automatic Internet Detection	Yes	Yes
Background Workers	Yes	Partial
Complete/Submit Assignments	Yes	Yes
Create Assignments	Yes	Yes, limited in types
Grade Assignments	Yes	Yes
Postdate created content	Yes	No
Recorded Videos	Yes	Yes, may not auto record
Reporting	Yes	No
Timestamp Completed Assignments	Yes	Yes
Video Conferencing	Yes	Yes
Weighted Priority Queue	Yes	Yes

Table 1: Inclusive Classroom Real-World Product vs Prototype

2.3 External Interfaces

The Inclusive Classroom prototype will require critical hardware and software components to ensure users can interact with the application. The hardware required for Inclusive Classroom will ensure that the application is accessible to users. The software required for Inclusive Classroom will ensure optimal performance of the application and desired functionality for users.

2.3.1 Hardware Interfaces

Inclusive Classroom will require a Windows 10, Mac, or Chromebook client device to utilize the client application. Inclusive Classroom will require a wired or wireless internet connection for initial installation of the application and for a final submission of coursework at

the end of a school year. Inclusive Classroom's server-side API will be hosted on Amazon Web Services' Simple Storage Service (S3).

2.3.2 Software Interfaces

Inclusive Classroom will consist of a client application and a back-end API each with their own software requirements. IC's client application will be a React Native web, Android, and iOS application to ensure optimal accessibility for users. The client application will use a SQLite Database for local storage. The API will use Node.js to execute JavaScript on the server-side of the application. Inclusive Classroom's API will use Express.js built on top of Node.js to increase functionality and handle HTTP requests. The API will communicate with a server-side PostgreSQL database.

2.3.3 User Interfaces

Inclusive Classroom's client application will serve as an interface between the user and the API (Team Gold, 2021). For users to interact with Inclusive Classroom, they must possess one of the appropriate devices listed in section 2.3.1 and have the application installed on their device. Users will need a device with either a mouse and keyboard or touchscreen to interact with the Inclusive Classroom application. Inclusive Classroom will require all user types to successfully authenticate to access their account.

2.3.4 Communications Protocols and Interfaces

The Inclusive Classroom prototype will communicate with the API using the HTTP standard starting with RFC 2068 and including subsequent updates.