

ChallengeIt

Building the 21st Century classroom economically

Abstract— What if the boring classroom experience can become an immersive, effective and engaging game for both the student and instructor? What if a student could be motivated to accomplish more than just the learning requirements of a class? To make these things real, we propose ChallengeIt: a mobile application that allows students to compete with one another on challenges in their classrooms in a fun and interactive manner. The classroom can now be supplemented with a targeted “game”, where students can earn points by completing challenges, and having their instructors review those answers and award points. And students are free to use any medium or combination of media with which they prefer to respond to these challenges (text, PDF, photos, videos, etc.). This will make them able to always participate in the class (both at school and at home) in a way that makes them most comfortable. If the instructor so chooses, real-world problems could also be introduced into our solution, thereby allowing student efforts to be channeled into real-world solutions. In this paper we will introduce our ChallengeIt interactive game and cover the design and development details from a software engineering aspect.

Keywords— *Serious game; interactive learning; engaged classroom.*

I. INTRODUCTION

Lack of student engagement and motivation in modern-day classrooms is an important problem not only for the students in the United States but also for the whole country if we consider its economic aspect. Indeed, a study shows that in Wisconsin, the dropout rate of high school students is about 10 percent each year in the last decade [3]. One reason this could be happening might be the increased prevalence of technology in our day-to-day lives and how it has made us unable to focus on any particular task for long periods of time. Why not using these technologies to make students focus instead? Technology has also introduced fundamental new forms of communication: forms that are ingrained in young adults from a very young age and represent their most comfortable manner of interaction. Essentially, adapting schools to address these issues would require a fundamental paradigm shift in the way we prepare and conduct education globally. Indeed, up-

coming generations of students are real digital natives, technology is part of their everyday life, and they are immersed in interactive environments using social networks or instant messaging applications. Indeed, current study suggests that Net Gen students are more likely to engage digital interaction than to interact with other students or the instructor when in a face-to-face learning environments. However, despite the waves of new technologies, the educational system remain mostly intact and does not provide the expected technologies in the classroom. Besides, nowadays, it is simple to enhance education with digital interaction for Net Gen's students because most of them own suitable devices like smartphone or tablet [4]. In parallel, current study shows that digital gaming has largely unrealized pedagogical potentials. Indeed, game-based-learning forces student to take an active approach to learn with rapid feedback and clear consequences leading to higher engagement and improved learning [5]. These games, which are designed for serious purposes like education, are called serious game [6]. Serious games seem to be a promising approach for these purposes, and in fact, the serious game market is blooming with an impressive growth. According to a study from the Audiovisual and Telecommunication Institute of Europe (IDATE), world Serious Game market, which was worth 2 billion dollars in 2010, will worth 14 billion in 2015 [7].

ChallengeIt looks to utilize technology that most children already have and use it to create an interactive and fun environment to further studies both within and outside the classroom. There already have been a number of commercial successes in fitness, task completion, and healthy living. More specifically, in the field of education, the Classroom Response System from Carnegie Mellon University employed a proprietary response system designed for use inside the classroom [1] and the WE Learn global initiative by Qualcomm Incorporated tried to deploy large amounts of highly customized and specialized 3G smartphones to connect students and teachers wherever they might be [2]. This latter solution is relatively recent and was relatively successful, indicating that the idea of using smartphones for education has merit and potential worth exploring. We are hoping to achieve similar results with ChallengeIt by incorporating an additional fun-factor, but at a much lower cost to students, parents, and schools.

The main contribution of this research project is to introduce the project ChallengeIt, a step forward in building the 21st century classroom as the project WE Learn global initiative intend to do but in a cheaper way. We also want to expose the important software decisions to make it cheap, easy to set up and performant, and develop a first prototype of ChallengeIt that could be used in pilot classrooms at [deleted for blind-review] University.

The paper is organized as follows: Section II will highlight related work in using serious gaming for learning; the project description, requirements, and application features will be discussed in Section III; the design specifications of ChallengeIt project will be demonstrated in Section IV; initial prototypes of the project are demonstrated in Section V; Section VI will give project development activities; and Section VII will restate the highlights of this paper.

II. STATE OF THE ART

This section will briefly review different attempts for integrating digital technologies in the classroom. It is not made to be exhaustive but simply for understanding what are the different approaches available today and what are their limits. Three categories were investigated: edutainment games, mobile apps, and interactive tools in the classroom.

A. Edutainment Games in the Classroom

This subsection is considering two edutainment (educational entertainment) games integrated in the classroom: “Innov8” and “Kids and Cookies”. Innov8 by IBM is a serious game that simulates a business environment to illustrate how Business Process Management (BPM) could be used in the professional world [7] Kids and Cookies is an interactive game designed for elementary students. The game is an interactive way of introducing number concepts. Users simulate sharing cookies while investigating the concepts of rational numbers and division [8]. Edutainment games address specific subjects and they incorporate the specific knowledge that the user should learn on the subject. The serious games being as complex as the subject they are addressing, their development could become easily limited financially, especially for high level and complex courses. Lastly, in these two examples, the instructor has no control upon the interactions.

B. Interactive Classroom Tools

Microsoft conceived an interactive classroom, which is a PowerPoint, and OneNote add-in that allows the instructor to insert customized classroom polls and notes into his presentation in real-time [9]. However, this proprietary tool is not containing any gaming or entertaining aspect, and is not suitable for student’s mobile devices. Other interactive tools for classroom like interactive board also remain purely academic and do not contain an entertaining aspect.

C. Apps in the Classroom

The success of mobile application in education can be proved by their numbers, for example, App Store is recording 65 000 apps for education [9]. Apps in the classroom are usually either simple serious game specific to a subject, or utility apps that are used as a learning tool. Serious games have specific knowledge incorporated into the app, and allow the

student to study or to train for a specific subject. Utility apps can help the student during classroom like Moment Diary, which is private diary that assists the student to log learning contents [10].

From the attempts of integrating digital technologies in the classroom that were reviewed, it seems that the current entertaining approaches are trying to replace the instructor for a specific training more than to provide an interactive environment. On the other hand, interactive tools are remaining utilitarian and academic, and are not considering the advantages of the game approach. Furthermore, it seems that the more complex the learning subject is, the more complex and expensive the solution to be developed is. Our proposed edutainment approach, the ChallengeIt project, addresses these limitations by providing an interactive game-based environment that can be customized by individual users.

III. PROJECT REQUIREMENTS

A. Project Description

The underlying project, namely ChallengeIt, proposes an innovative approach based on challenges for creating an interactive game-based application to integrate in the classroom. ChallengeIt is harnessing the power of challenges with an interactive mobile application. As current study explained, educators should use challenges in a serious gaming context to improve learning [11]. However, in contrast to most usual serious games, ChallengeIt will not contain any incorporated knowledge. Our contribution resides in establishing an instructor-monitored interactive platform that emanates a challenging dynamic for the student.

For ensuring its success and acceptance upon students, the application will incorporate a similar ergonomic navigation that the popular apps like SnapChat and Facebook Messenger use, but with its own particular look. A rich variety of formats is available to users for interacting with one another, including the use of multimedia. As it is necessary in a game, there is a winner, one for each challenge made and the total score of each student should be exposed, so that students can enhance their motivation with the competition aspect of the game. With ChallengeIt, the class environment changes into a game. In parallel, it is a tool for the student to collect and record their works and feedbacks in one single environment.

Separately, in higher-level classes, external actors might use ChallengeIt for suggesting their own challenges to the students. In that way, problems of the real world might become the challenges of students. Concretely, ChallengeIt will be a communication app that students can download on their smart devices. Each game may correspond to a class but also to a group. For each game, a master player (e.g. the instructor or the student proposing a challenge) is required who control the game, and players that play the game. The user could navigate between different frames:

- One frame will show a list of all the ChallengeIt games of the user in which he is playing on,
- One frame will show a list of all the ChallengeIt games of the user in which he is the master for,

- One frame will allow the user to create a message by either taking a picture/video, sharing a file or writing text,
- One frame will allow the user to access/edit settings and his profile information,
- One frame will allow the user to find other users and add them as “friend”.

By clicking on a ChallengeIt game in the first frame, the user can access the current and past challenges of the selected game as well as the score accumulated. The second frame will be used for creating a challenge or for responding to one. In the case of a challenge creation, the user shall add time and score points to the message. If the challenge is created by someone else than the instructor, the instructor should approve the challenge in order to be broadcasted. At the end of the semester, the score of the student could be used for attributing a participation grade or extra-credits.

B. Environment

It was decided to implement ChallengeIt on Android because Google Play is today the most widely used mobile platform and it is the most accessible considering the lower cost of certain Android devices. Three types of users were considered: instructors, students, and external challengers. The project's main stakeholders are the educational/learning institutions. We are also anticipating two major constraints: student privacy and human subjects (both dictated by the “user” institution and can be addressed according to their regulations).

C. Top-Level Requirements

ChallengeIt top-level requirements are outlined next, keeping in mind two major types of users: the *user* (a person using the application), a *master* (the instructor who will have specific rights). A player is a user that is playing a game, i.e. following the classroom activity. The proposed system shall:

- Allow the player to suggest a challenge to the master.
- Allow the master to weight a challenge with points.
- Allow the master to set a deadline for the challenge.
- Allow the master to broadcast a challenge to players of a game using video, photo, file or text.
- Allow a player to submit response to a challenge using video, photo, file or text.
- Allow the master to provide score feedback to each submitted response.
- Record each submission.
- Allow the master to access every submission.
- Allow the user to access the challenges' information in which he is involved.
- Allow public challenges in which all players' submissions are accessible by the players in that classroom.
- Allow private challenges in which only selective players can participate at.
- Announce the winner name of a challenge.
- Announce the rank and current scores of the public players.
- Allow a user to be a private or a public player.

D. Functional Requirements – Usecase Model

To demonstrate the system's features and their invocation by users, we present the usecase diagram in Fig. 1. There are eighteen usecases which explain the options available to the users including creating, deleting, broadcasting, and accessing a challenge/game, as well as inviting players.

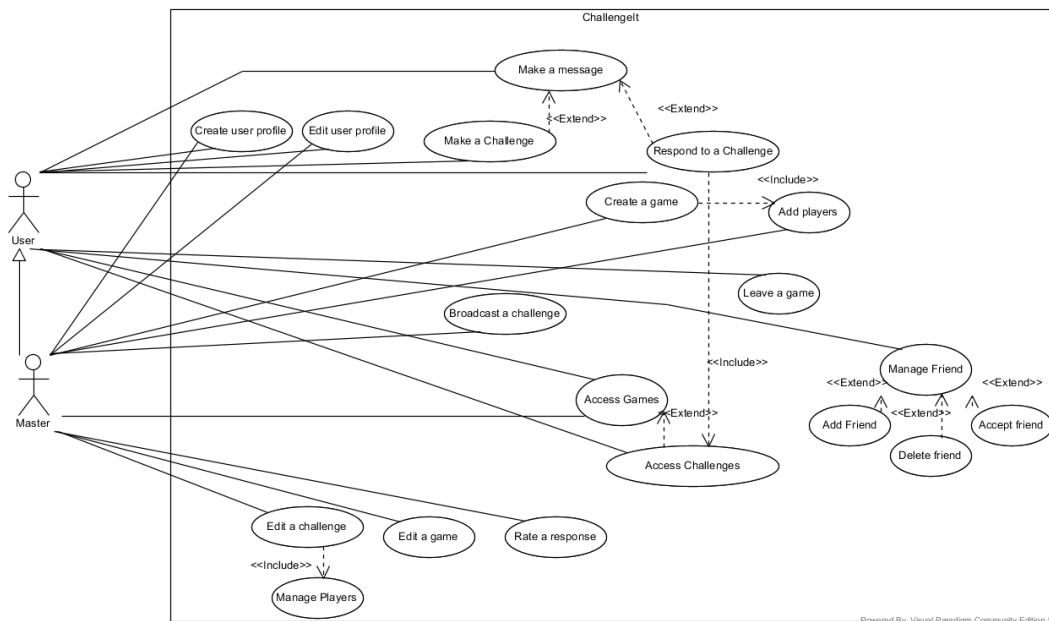


Fig. 1. ChallengeIt usecase diagram.

E. Application Views

The following is a list of suggested views that should be present in ChallengeIt. For clarification, a master is the role of a user who moderates all challenges in a game, adds additional challenges as they become available, and controls access to their game (eg. an instructor). A player is any user who participates in a game. Students are free to add or remove any views they deem relevant to the particular version they are working on:

- View to display a list of all games that the user is either a player in or master of,
- View that shows all of the challenges for a particular game and the rank of all participating players.

- View that displays the details of an individual challenge,
- View that allows the user to respond to a challenge with a message and media content (such as text, images, or file attachments),
- View that allows the game master to review challenge responses and award points,
- View that allows the user to access any app settings and profile information,
- View that allows users to search for other users, as well as view and edit a list of friends.

IV. PROJECT DESIGN

The high-level design of ChallengeIt is illustrated on Fig. 2, demonstrating the system's class diagram.

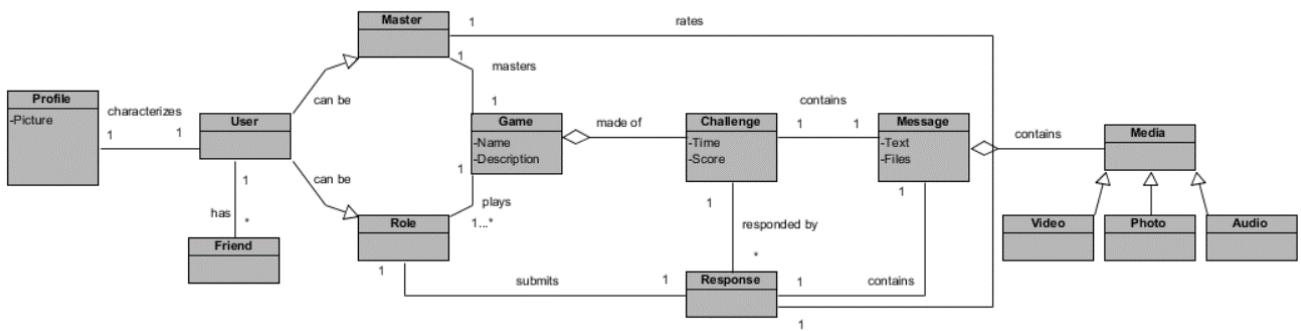


Fig. 2. ChallengeIt domain model diagram.

A user can sign into the application through their Google account. Once in, the user will have access to five functionalities: Create/Edit Game; User's Games List; Message

Creation; Friends; and User Profiles. The activity diagram in Fig. 3 demonstrates these options.

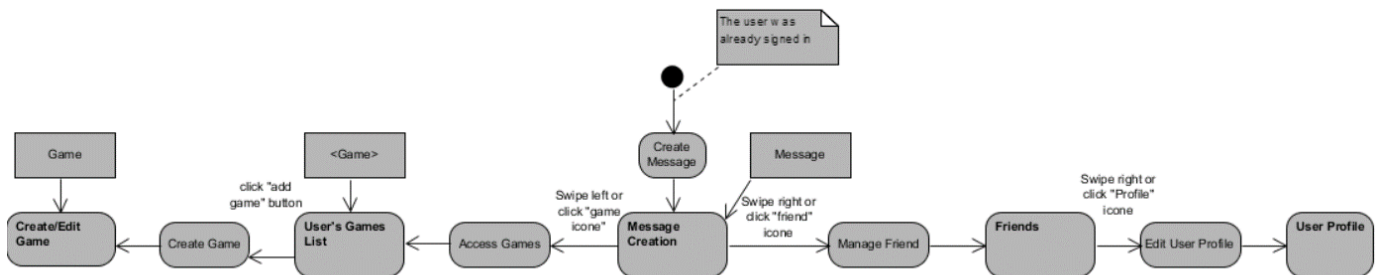


Fig. 3. Main activity navigation.

F. Non-functional Requirements

The non-functional requirements of ChallengeIt are as follows:

Reliability requirement:

- Under usual internet access (at least 1Gb of download), 99% of transactions shall be accomplished.

- Every instance that to be persisted shall be duplicated at least one time (so that there is at least two versions of the same data saved).

Availability requirement:

- Under usual internet access (at least 1GB of download), ChallengeIt shall be accessible and working 99% of the time.

Security requirement:

- Every user account shall be secured using a password of at least 8 characters.
- The user login shall be done using SSH protocol.

Maintainability requirement:

- If a user experienced data loss, the backend administrator shall be able to recover it in less than 2 business day.

Portability requirement:

- Every user account shall be secured using a password of at least 8 characters.
- The user login shall be done using an SSL connection.

V. INITIAL PROTOTYPES

In order to have a better understanding of the system, initial prototypes were developed for Message Creation, Main Game Panel, Game Creation, and Edit Profile.

A. Message Creation

In the same way of popular apps like Instagram or Snapchat, ChallengeIt was decided to be a message-oriented app. The user creates his message and then decides what he wants to do with it. One of the main innovations of ChallengeIt is its new

way of creating messages. It was especially decided to allow the user to enjoy the variety of media offered by the mobile devices combined with the usual functionalities of the email system. Thus, the message creation is composed of two parts:

- A media section, in which users can take a picture, a video or a voice record.
- An email section, in which users can write text, and attach files.

By opening the app, illustrated on Fig. 4, the user is directed into the initial mode (a) where he/she can start recording a media or swipe down the dashed 'T' for accessing the email part. By swiping the email part up and down with the dashed T button (or the dashed square button) the user can go through different modes: the full media mode (Fig. 4-b), and if he has already had recorded a media, the full media mode (Fig. 4-c) or the dual mode (Fig. 4-d). Every part of the message is editable so that the user can revise and validate the message before sending it. Message validation is done when the user decides to make the message into a challenge or into a response to a challenge by clicking on the appropriate button on the action bar.

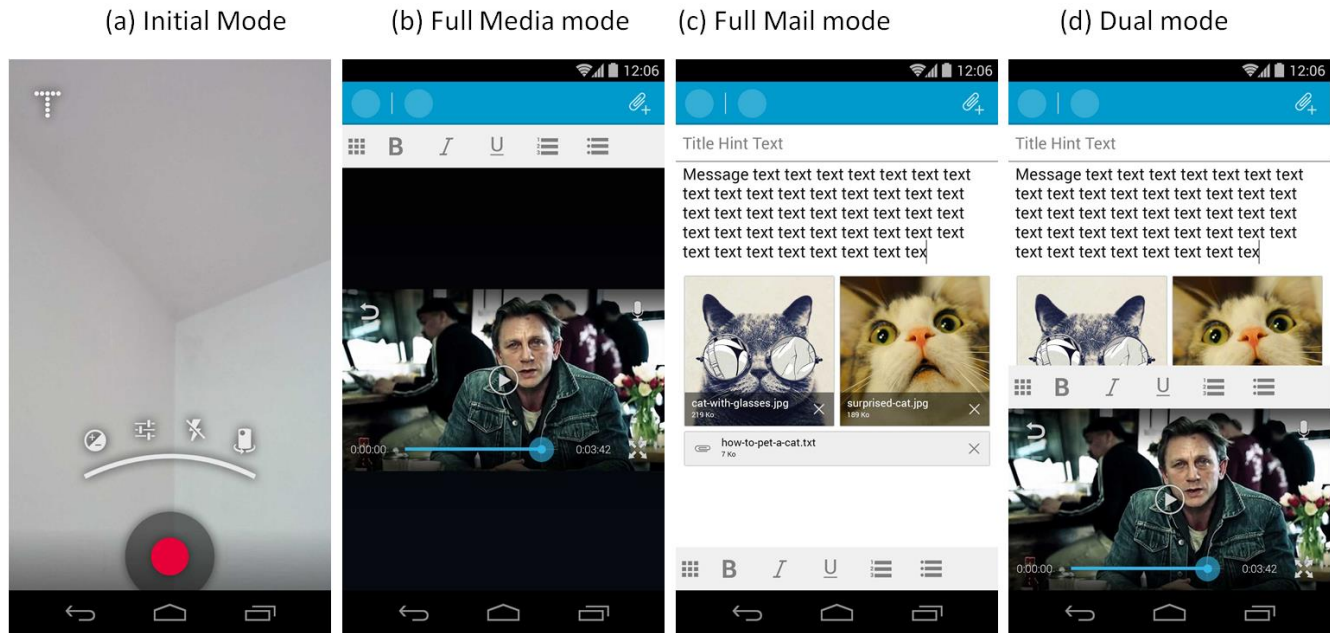


Fig. 4. Message creation.

B. Main Game Panel

A user can either play to a game or master it. He can thus access two different lists: the list of the games he is mastering and the list of the games he is playing. From each of these lists, he can access the challenge list of the selected game. As shown on Fig. 5 (a), a game item contains the title and a short description of a challenge, the player name of the game, the actual score of the game (in green), the number of challenges currently available, and the total score that the user can earn by doing these challenges.

Fig. 5 (b) shows the challenges available/completed for the user. The list shows the challenges in their expiry order (the

most recent challenges are at the top, where completed ones are at the bottom of the list). A challenge item contains the title of the challenge, a short description, the number of days left to complete the challenge, the score value of the challenge and a thumbnail of the media (if there is any). If the challenge was completed, a picture of the winner is displayed instead of the media thumbnail, and when clicking on the item, the user can see the winning response.

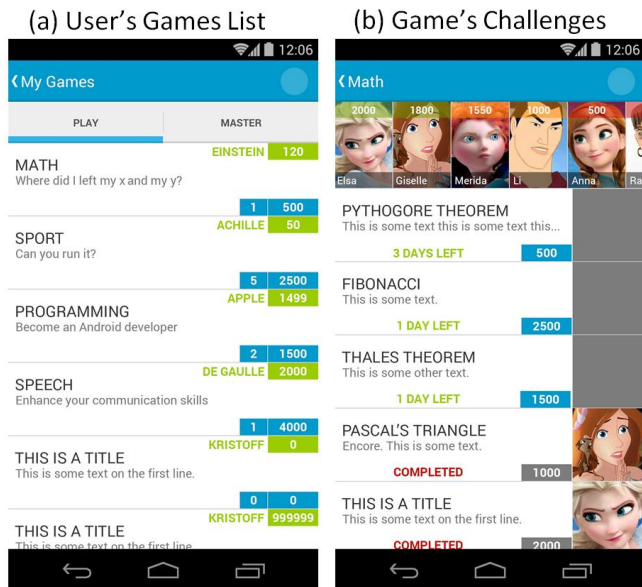


Fig. 5. Games and challenges list.

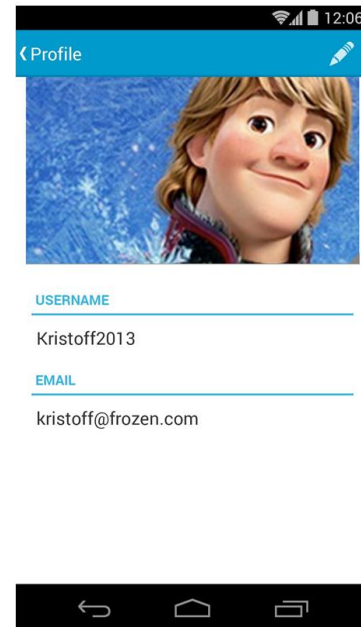


Fig 7. Edit profile and app settings.

C. Game Creation

Fig. 6 illustrates game creation feature, where the user can easily create a game by setting up some basic settings on the game and then selecting players from friends list.

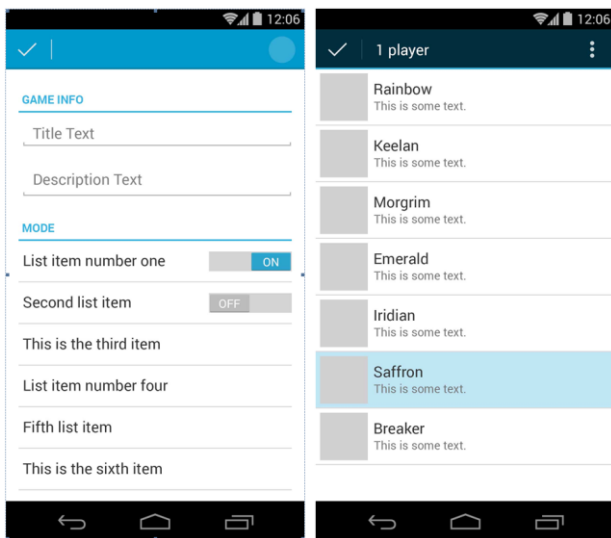


Fig. 6. Game creation and player selection.

D. Edit Profile

Fig. 7 demonstrates how a user can select to edit his profile settings by changing the profile picture, username, and other related app settings.

VI. PROJECT DEVELOPMENT

Based on the requirements analysis and design specifications of ChallengeIt, project implementation activities were developed. Table 1 demonstrates these activities and the estimated development plan for each task. A fully functional Android or iOS development environment should be installed prior to beginning development of the mobile application. The rest of this section outlines the development activities and provides their details.

The development team should first focus on designing, implementing, and testing the user interface of ChallengeIt (i).

This will not only set the tone for how the application will look and feel, but it will quickly reveal the types of data, data structures, and data operations that will be required for proper operation of the app. This information would then inform the creation and testing of the appropriate NoSQL database to be used in conjunction with the persistence framework and Google Cloud Endpoints (ii). Once integrated together, application functionality could be thoroughly tested with a local instance of this database using the provided Google Datastore Explorer and the generated client endpoint libraries (iii).

Finally, the app and cloud back end should be deployed to the web (iv) for further integration testing and real-world testing with beta users. Once any bugs or user feedback issues are addressed, the app can be fully released for consumers, and complete system and market analysis can be completed (v-vi).

TABLE I. CHALLENGEIT – PROJECT DEVELOPMENT ACTIVITIES

Tasks	Activity	Time	Major Skills
Mobile User Interface (i)	<ol style="list-style-type: none"> 1. Design the application user interface (eg. view screens, navigation hierarchy amongst them) for all views described in the list below (titled “Application Views”). 2. Implement a wireframe mobile application that incorporates the overall navigation hierarchy with placeholder views. 3. Replace each of the placeholder views with final iterations of the previously agreed upon designs. 4. Test application navigation and screen rendering on a variety of device form factors (eg. phones, phablets, tablets) to ensure that everything is working or appearing as expected. 	60 h	<ul style="list-style-type: none"> - UX Design - Mobile OS UI Best Practices - Mobile App Development
Cloud Backend(ii)	<ol style="list-style-type: none"> 1. Design the database object schemas and determine the relevant database operations that will be required. 2. Implement the database objects using a compatible persistence framework¹ and the database operations using the Google Cloud Endpoint APIs. 3. Locally test the APIs and database objects to ensure that the implementation is correct and make any changes as necessary. 	100 h	<ul style="list-style-type: none"> - Persistence framework - SQL
App Integration (iii)	<ol style="list-style-type: none"> 1. Generate the Cloud Endpoint client libraries for the mobile app OS that will be used. 2. Import the client libraries into your project and add the needed backend logic to use App Engine to implement all of the ChallengeIt functionality. 3. Test application functionality and integration with App Engine using the Google Datastore Explorer locally. 	60 h	<ul style="list-style-type: none"> - Mobile App Development - SQL
Deployment on the App Store and Cloud Backend (iv)	<ol style="list-style-type: none"> 1. Deploy the cloud backend on Google App Engine. 2. Deploy the app on the appropriate app store for beta testing. 3. Correct and test any bugs or user complaints for your beta version. 4. Re-deploy app for general release on appropriate app store. 	50 h	<ul style="list-style-type: none"> - Cloud Deployment - Customer Relations - Code Testing
System Analysis (v)	<ol style="list-style-type: none"> 1. Estimate the percentage of consumers who are inactive during classes through publicly released reports and statistics. 2. Determine the change in inactive consumers during class through analytics of app usage after integration of ChallengeIt into the classroom. 3. Estimate the costs involved for every individual to use the application including updating and formatting the same. 	30 h	<ul style="list-style-type: none"> - Economics - Quantitative Reasoning
Market Analysis (vi)	<ol style="list-style-type: none"> 1. Recognize target market (for example the number of people using smartphones during high school). 2. Reach out to the target by creating awareness of the application through public media such as radio, newspaper, advertisements and outreach programs. 	30 h	<ul style="list-style-type: none"> - Marketing - Communication Skills

The project needs an estimated 330 hours of work to complete from start to finish for an individual with working knowledge

of any required programming languages, but no practical experience with mobile or cloud technologies. Any additional

knowledge of technologies used in this project could easily reduce development time.

A. Required Technical Skills and Material

The development team will need access to Android Studio (development environment) and Google App Engine SDK, and should have general knowledge in:

- Java (Android) or Objective-C (iOS)
- Android or iOS SDK
- NoSQL (App Engine Database)
- JPO, JPA, or Objectify (persistence library for use with App Engine objects)

The team should also be utilizing some sort of version control system, such as Git or Subversion.

VII. CONCLUSION

This paper discussed the objectives, design, and implementation details of a novel game-based learning environment, ChallengeIt, which is deployed on smart phones and handheld devices. ChallengeIt provides an innovative solution as it represents a fusion of the edutainment game genre and the interactive classroom tool. It is cheap to implement/use, easy to use, and provides convenient access to learning activities wherever the student is at any time. ChallengeIt also represents a departure from previous attempts to implement game-based digital classroom. At this moment, ChallengeIt project is still under development and currently in the implementation/testing phase. Once the product is implemented and tested, we will be using it in our classrooms to assess its usability and performance.

With ChallengeIt, we look to utilize technology that most children already have and use it to create an interactive and fun environment to further studies both within and outside the classroom. By presenting students with course-related “challenges” by their instructors, students would compete between each other for the most number of correct answers and also be forced to learn new concepts outside the normal course requirements to be able to complete them.

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