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The Impact of Gamified Mobile Applications for Disease Management: Case Study Pre-Diabetic Adolescents

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THE IMPACT OF GAMIFIED MOBILE APPLICATIONS FOR DISEASE MANAGEMENT: CASE STUDY PRE-DIABETIC ADOLESCENTS

By

Obie Wesley McGowan Jr

A THESIS

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

In Medical Informatics

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This thesis has been approved in partial fulfillment of the requirements for the Degree of MASTER OF SCIENCE in Medical Informatics.

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In Living Memory of

Delores (Tiny) Raines

And

Obie J. McGowan Jr.

Abstract

In 2014, diabetes was the seventh leading cause of death in the United States [1]. According to the Centers for Disease Control and Prevention (CDC), one third of all adults in the United State are pre-diabetic. Pre-diabetes is a condition in which blood glucose (sugar) is higher than normal, but not yet high enough to be diabetic. Persons who have an increased risk of developing pre-diabetes are: those who are not physically active, have a family history of diabetes, are within a minority group, are overweight/obese, and other factors. From 1999 to 2008, the occurrence of adolescents ages 12 to 19 with pre-diabetes or diabetes increased from 9% to 23% [5]. The purpose of this study is to determine whether deploying a gamified mobile application will help reduce adolescent's risk of developing Type 2 diabetes, as well as increase the quality of user care.

Technology can greatly enhance a user's ability to self-manage and lower their risk for pre-diabetes. Considering the varied uses of smartphones, it is not unusual for an application to be used to help pre-diabetics manage their health. Smartphone applications are currently being used to manage fitness, diet, glucose levels, water intake, blood pressure, heart rate, and weight. In a 2015 study conducted by the Pew Research Center, 88% of all American adolescent's ages 13 to 17 have or have access to a mobile phone, with 73% owning a smartphone. This study also shows that 72% of all adolescents play video games and that 81% have or have access to a gaming console [11]. This data shows the potential for mobile gamified applications in pre-diabetic user care.

Introduction

Diabetes was the seventh leading cause of death in the United States in 2014. Estimations for 2035, predict that more than 592 million people will be diagnosed with Type-1 and Type-2 diabetes worldwide [1]. According to the Centers for Disease Control and Prevention (CDC), one third of the 86 million adults in the United States are pre-diabetic. Of this population, 9 out of every 10 people are not aware that they are pre-diabetic. Pre-diabetes is a condition formerly known as Impaired Glucose Tolerance (IGT) or Impaired Fasting Glucose (IFG). Individuals that are pre-diabetic have a blood glucose (sugar) level higher than normal but not yet high enough to be considered diabetic. A person can increase their risk of developing pre-diabetes if they are not physically active, have a family history of diabetes, are within a minority group[1], or are overweight/obese. Other factors that can contribute to pre-diabetes are: high blood pressure, high blood fat[2], high blood glucose levels while pregnant[3], birthing a nine pound baby or more, individuals with Polycystic Ovary Syndrome (PCOS), and individuals aged 45 years or older [8, 17].

Studies show that being aware of a pre-diabetic condition can allow a person to reduce their risk for developing Type-2 diabetes by 58%. This can be done by exercising daily for 30 minutes or more, healthy eating, switching from carbonated beverages and juice to water, and losing 7% of their body fat [8, 17, 21]. The idea of placing responsibility for improved health with the user is known as *self-management*. Tenants of *self-management* include: a healthier diet, physical activity, developing coping skills, and

[1] American Indian, Asian American, Black American, Hispanic/Latino, or Pacific Islander
[2] cholesterol and triglycerides
[3] gestational diabetes

tracking blood glucose levels. Leveraging technology through the development of smartphone apps can greatly enhance a user's ability to self-manage and lower their risk for pre-diabetes. This research project focuses on developing a health monitoring gamified application for Android devices that will assess and track health, calculate risk factors, and educate the user about their condition in a gaming environment.

Diabetes

Diabetes Mellitus (diabetes) is a group of metabolic diseases marked by high levels of blood glucose[4] resulting from the body's inability to produce enough insulin or use insulin effectively [2, 3, 7]. The most common forms of diabetes are Type-1 and Type-2. For Type-1 diabetes, (also known as juvenile diabetes, insulin-dependent diabetes, or early-onset diabetes) the body fails to produce insulin, which leads to the attacking of beta cells[5] by the immune system. Type-1 diabetes usually develops during childhood or early adolescence.

In Type-2 diabetes, also known as Non-Insulin-Dependent Diabetes, the body fails to use insulin effectively or the body is insulin resistant. Insulin is a hormone produced by the pancreas that regulates the amount of blood glucose in the bloodstream [10, 20]. Type-2 diabetes is most common in middle-age or overweight/obese adults.

Some symptoms associated with being diabetic include frequent urination, blurred vision, and extreme thirst and fatigue. Diabetes can affect multiple organs in the

[4] blood sugar or hyperglycemia

[5] any of the insulin-producing cells in the islets of Langerhans

body and cause complications such as kidney failure, blindness, heart disease, stroke, nerve disease, gum disease, erectile dysfunction, non-alcoholic fatty liver disease, and hearing loss.

The development of pre-diabetes and Type-2 diabetes is becoming a nationwide epidemic. The American Academy of Pediatrics conducted a study that showed pre-diabetes among adolescents aged 12 to 19 rose from 9% to 23% between 1999 and 2008 [5]. The study indicated that overweight/obese adolescents are more likely to have risk factors for cardiovascular disease (CVD), which includes high cholesterol and/or high blood pressure. Overweight/obese adolescents are more likely to develop pre-diabetes than adolescents who maintain a healthy lifestyle. According to the CDC, obesity has doubled in children and quadrupled in adolescents over the past 30 years. The number of overweight/obese adolescents from ages 12 to 19 increased from 5% in 1980 to 21% in 2012 [2]. Adolescents, who are be overweight or obese, are more susceptible to being overweight/obese as adults. If these adolescents do not alter their lifestyle, they could develop Type-2 diabetes. Between 2008 and 2009, more than 18,000 of the American youth were diagnosed with Type-1 diabetes and more than 5,000 with Type-2 diabetes [2].

Diabetes management has been a difficult challenge for the healthcare industry and its users. Diabetes is more prevalent in lower income and rural area communities. This factor may be related to limited access to healthcare facilities and a lack of educational tools and resources, which promote healthy living.

Research shows that in Michigan, 27.69% of people ages 21 and younger either have or will develop diabetes. In the Upper Peninsula, that number is slightly lower at 24.10% [3]. The cost of monitoring a diabetic condition in the U.S. is estimated at $245 billion annually. This figure includes $69 billion of indirect costs such as disability, work loss and premature death, as well as a direct cost through medical expenses of $176 billion [4].

The average medical expenses of diabetics are 2.3 times higher than individuals without diabetes. Diabetics have a 50% higher death rate, and possess a higher risk of dying each day than a non-diabetic, leading to a shorter life span [2]. Without health insurance, medical expenses for diabetics could cost anywhere from $231 to $361 per visit, which includes $49 for glucose labs and $73 for glucose hemoglobin tests [16]. With an average statewide per capita income of $25,547, these expenses are not feasible for a significant number of Michigan residents. An individual living in a household in the Upper Peninsula that earns less than $25,000 annually has a significantly greater risk of developing diabetes.

Testing for Diabetes

A doctor may run one of three standard tests to see if a user is pre-diabetic or diabetic. These include A1C tests[6], Fasting Plasma Glucose (FPG) tests[7], and Oral Glucose Tolerance Tests (OGTT)[8] [6, 8]. The A1C test measures the average blood

[6] Normal – below 5.7 percent, Pre–Diabetes – 5.7 to 6.4 percent, Diabetes – 6.5 percent or above
[7] Normal – below 110 mg/dl, Pre-Diabetes – 110 to 125 mg/dl, Diabetes – 126 mg/dl or above
[8] Normal – below 140 mg/dl, Pre-Diabetes – 140 to 199 mg/dl, Diabetes – 200 or above

sugar over the preceding two to three months. An advantage of conducting this test is that the user does not have to refrain from eating or drinking prior to its admission. A user should have an A1C test once a year for pre-diabetes, twice a year for Type-2 without insulin, three to four times a year for Type-1, and four times a year for Type-2 with insulin. If a user's blood glucose levels are normal, a user should be tested every three years. The FPG test measures blood glucose levels after a user has fasted[9] for a minimum of eight hours. This test is the preferred method of testing the user for pre-diabetes or diabetes because it is easier to perform and cheaper in cost relative to the other two tests. The OGTT test is a two-hour test that measures blood glucose levels after a user drinks a special sweet drink[10]. The OGTT test is given to pregnant women to check for gestational diabetes. The OGTT is also given if a user has given birth to a baby weighing 9 pounds or more or if a user is younger than 25 years of age and is overweight/obese prior to pregnancy.

Mobile and Gamification Technology

967 million smartphones (20% of the world's population) were sold in 2013. By 2017, smartphone sales are projected to reach 62.2% of the population in North America alone [18], and project that 80% of all mobile users will own a smartphone in the United States, up from 26.9% in 2010 [18]. In the 2015 Pew Research Center study (Teens, Social Media & Technology) it was found that 88% of all American adolescents ages 13

[9] drinking only water

[10] a 5 ounces glucose solution that contains 50 grams of sugar

to 17 have or have access to a mobile phone, with 73% owning a smartphone [11]. This study also shows that 72% of all adolescents play video games and 81% have or have access to a gaming console. The purpose of this study is to determine whether deploying a mobile gamified application in a rural area will help reduce a person's risk of becoming pre-diabetic or prolonging the development of Type 2 diabetes, as well as improve the quality of user care.

Related Work

Technology has been used to educate and train users to help improve their healthcare through self-management. For instance, Jerry the Bear is a plush bear with diabetes, developed by Sproutel, which turns managing a chronic illness into an educational game for Type-1 diabetic children [12, 15]. A child with Type-1 diabetes takes care of Jerry as if they were taking care of themselves. The child can feed Jerry by sliding Radio-Frequency Identification (RFID) food cards over his mouth. Each food card has a carbohydrate value that represents a different type of food. The child can check Jerry's blood glucose by pushing his fingers, which represents where a child should check their own blood glucose. Jerry uses this information to calculate the amount of insulin needed to balance the carbohydrates. After calculating the amount of insulin, the child can inject Jerry in six different injection sites with his insulin pen. Children learn the importance of calculating the correct amount of insulin through an interactive system. This system is used to educate and train both the parent and child on how to self-manage their diabetes. Jerry the Bear represents a physical game for Type-1

diabetes self-management training; whereas other research has been focused on virtual gaming.

"Escape from Diab" (Diab) and "Nanoswarm: Invasion from Inner Space" (Nano) designed by Archimage, Inc., are adventure video games designed to lower the risks of developing Type-2 diabetes and obesity by changing a child's diet and physical activity behaviors [14]. In a randomized clinical trial, data was collected from 133 children, ages 10 to 12 years old with a control group and a treatment group. Both groups were measured for weight, waist size, height, and triceps skin-fold thickness. This study found children playing "Diab" and Nano" increased fruit and vegetable consumption per day by 67% [14]. However, physical activity, water consumption, and body composition did not improve during the study.

Another game called "The Magi and The Sleeping Star" by Game Equals Life, is a self-management video game for diabetics in a fantasy world [13]. The main character has Type-1 diabetes, and the player must learn how to master the character's blood glucose before facing an ancient king that threatens the world. The user's character is the only one with the power to stop him, with the help of a robotic assistant AIMO. At the time of writing this, "The Magi and The Sleeping Star" was in the development stage with a Kickstarter campaign to raise money. Developing a game with limited access to resources can be a difficult task. For this reason and others, researchers are beginning to look at the implementation of self-management systems through mobile applications.

Proposed Project

The goal of this research is to develop a prototype mobile application to capture, track, and analyze adolescent health data (with the potential to conduct predictive analytics) in unconventional settings. This research will also develop technology games aimed at improving health, and it will provide the groundwork needed to establish a strong model of functional and successful health care mobile applications beneficial to both the user and the clinician.

Methodology

By employing this health monitoring gamified application, the goal was to (i) prevent/prolong adolescents from becoming Type-2 diabetics, (ii) educate adolescents and adolescent's parents/guardians on their pre-diabetic condition, (iii) help adolescents maintain a healthy lifestyle by altering their eating habits, and increase their physical activity. This goal was achieved by developing a mobile gamified application using Android Studio[11], XAMPP[12], Apache[13], PHP[14], and MySQL[15]. By using XAMPP build-in MySQL services, we created a database called "logtest". Within *logtest* were three tables named *user2* (user personal and superhero information), *skuser* (sidekick information),

[11] Android Studio version 1.5.1 - Android Studio is an open source Java integrated development environment (IDE) for developing application on the Android platform
[12] XAMPP version 3.2.1 was developed by Apache Friends is a free open source web server that consist of PHP, Pearl, MariaDB, and Apache
[13] Apache (Apache HTTP Server) running on port 80 and 443 - Apache was developed by Apache Software Foundation is a web server software
[14] PHP (PHP: Hypertext Preprocessor) running on ort 3306 - PHP is an open source scripting language designed for web development by Rasmus Lerdorf
[15] MySQL is an open source relational database management system (RDBMS)

and *percentage* (user training results). Table *skuser* and *percentage* are linked to table *user2* by *superusername* located in *user2* table. Using Android Studio, we created 15 XML layouts named *activity main, amaph, current_events, health_status, home, login, services, sidekick, signup, superherologin, techville, training, trainingresult, update,* and twenty-six Java files named *Activity, Ampaph, BMI, Circular, CircularProgress, ConfigBMI, ConfigPower, CurrentEvents, Education, Food, GetResult, HealthStatus, Home, Login, Mainactivity, RegisterUserClass, Services, Sidekick, SignUp, Sleep, SuperheroLogin, Techville, Training, TrainingResult, Typewriter, Update,* and *Villain*. To communicate between the database (MySQL) and Android Studio (Java) PHP files were created used named *dbConnect, getBMI, getPower, getResult, login, percentage, register3, register4, register5,* and *update*. Figure 1 shows the mobile gamified application layout from the point of view of Android Studio. Techville will serve as the gamification side and home/AMAPH will serve as the educational side of our application.

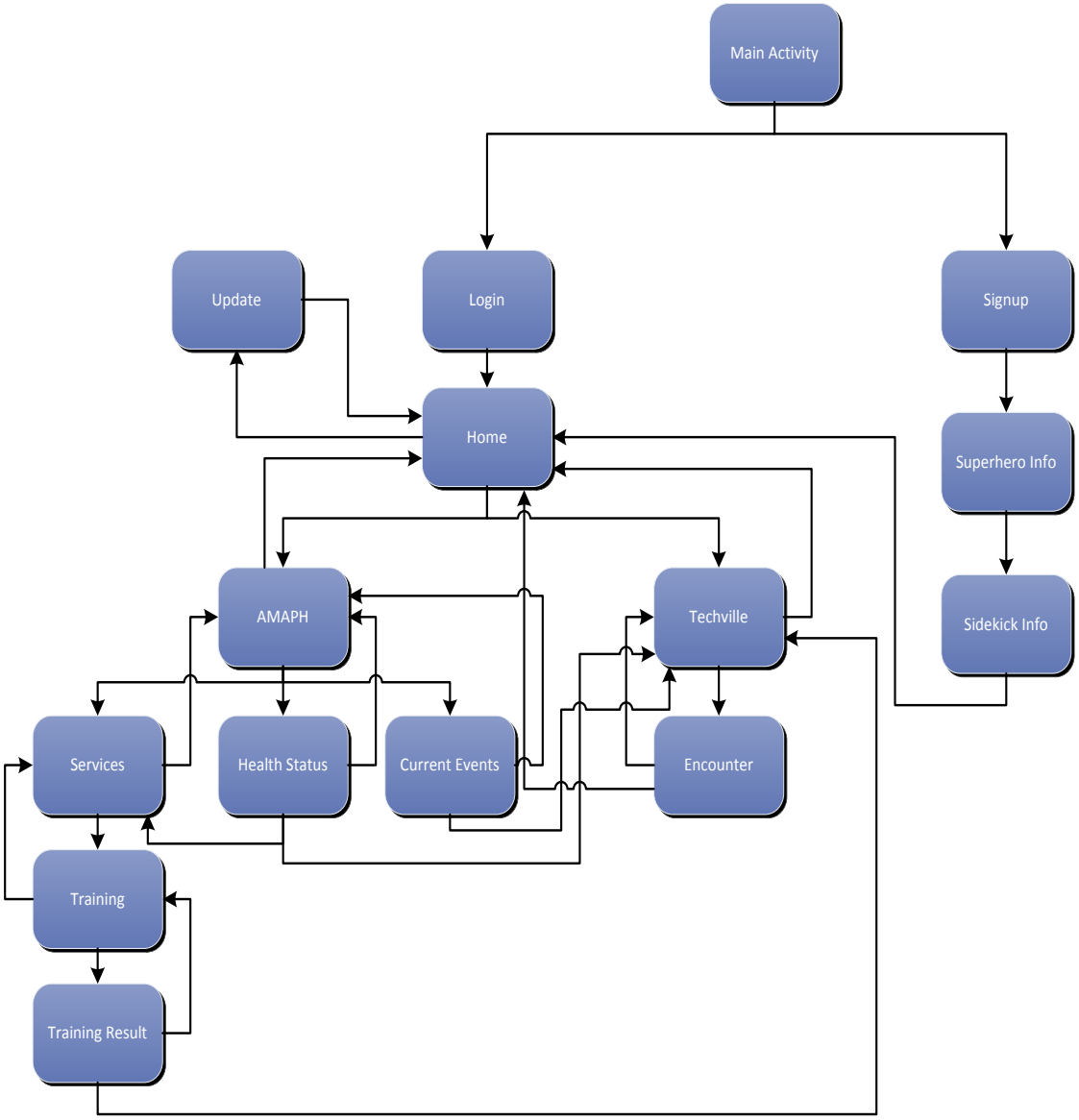


Figure 1: Application Layout

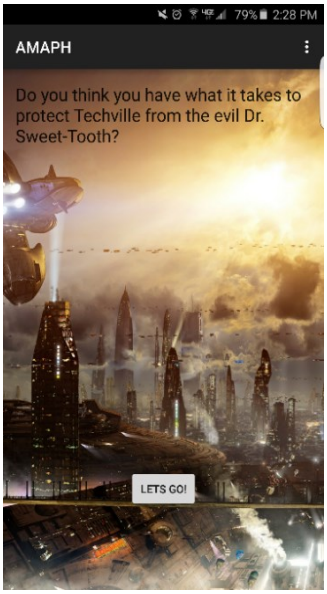


Figure 2: Main Activity Screen [16]

Once the application is open, the user is presented with the *Main Activity* screen shown in Figure 2. From this screen, the user can click the "Let's Go!" button, which will take them to the *Login/Register* screen. On this screen, the users can either login or register a new account. If the user already has an account, they can simply enter their "username" and "password". Let's say they entered username: "owmcgowa" and password "123". After the "Login" button is clicked, Java passes this information to a PHP file *[Figure 3]*. PHP receives this information, makes a connection to a database, and inputs this information into a MySQL statement *[Figure 4]*. This query checks the database to verify if the username and password matches. After verification, the database transmits the results back to PHP *[Figure 5]*. If this information is correct, a "success" message is transmitted back to Java as well as displayed on the screen *[Figure 6]*. The

[16] Figure 2 background image: Futuristic City 3 © Scott Richard, Source: Deviant Art, retrieved from http://rich35211.deviantart.com/art/Futuristic-City-3-updated-background-319511220 [27]

user is then taken to the *Home* screen. If this information is incorrect a message will display “failure”. If the user would like to create a new account, they can simply click “*Register*”. After this button is clicked the *Signup* screen will display.

```
@Override
protected String doInBackground(String... params) {
    HashMap<String,String> data = new HashMap<>();
    data.put("username",params[0]);
    data.put("password",params[1]);

    RegisterUserClass r = new RegisterUserClass();

    String result = r.sendPostRequest(LOGIN_URL,data);

    return result;
```

Figure 3: User's username and password is store and transmit

```
$con = mysqli_connect(HOST,USER,PASS,DB);

$username = $_POST['username'];
$password = $_POST['password'];

$sql = "select * from user2 where superusername='$username' and
superpassword='$password'";

$res = mysqli_query($con,$sql);

$check = mysqli_fetch_array($res);

if(isset($check)){
echo 'success';
}else{
echo 'failure';
}
```

Figure 4: Database connect and query

id	first	last	email	superusername	superpassword	birthday	gender	weight	height
47	wesley	mcgowan	owmcgowa@mtu.edu	owmcgowa	123	13	Male	100	54

Figure 5: Entry lookup

```
@Override
protected void onPostExecute(String s) {
    super.onPostExecute(s);
    loading.dismiss();
    if(s.equalsIgnoreCase("success")){
        Intent intent = new Intent(Login.this,Home.class);
        intent.putExtra(USER_NAME,username);
        startActivity(intent);
    }else{
        Toast.makeText(Login.this,s,Toast.LENGTH_LONG).show();
    }
}
```

Figure 6: Log users in and send to Home screen

On the Signup screen, the user is prompted to enter their first and last name, email, username, password, age, sex, weight in pounds, and height in inches. For

example, the user may enter: first name “Wesley”, last name “McGowan”, username “owmcgowa”, password “123”, age “13”, sex “male”, weight “100” and height “54”. All fields are required to continue to the next screen: *Superhero Info*. When the “Next” button is clicked, Java transmits their personal information to a PHP file *[Figure 7, 8]*. This PHP checks the user’s information for the following criteria and displays a message if:

- Fail to fill all fields – “Please fill all values”
- Password and Confirm Password do not match – “Password does not match!”
- The username and email already exits – “Username or Email already exists”

If all fields are filled correctly, the password and confirm passwords match, and previously nonexistent username and email, the user’s personal information will be stored in the database named “*logtest*” in table “*user2*” *[Figure 9]*. If successful, Java will receive a “successfully registered” message and the *Superhero Info* screen will display *[Figure 10]*. If unsuccessful, the user will receive an “oops! Please try again!” message.

```
private void registerUser() {
    String first = editTextFirst.getText().toString().trim().toLowerCase();
    String last = editTextLast.getText().toString().trim().toLowerCase();
    String username = editTextUsername.getText().toString().trim().toLowerCase();
    String password = editTextPassword.getText().toString().trim();
    String confirmpass = editTextConfirm.getText().toString().trim();
    String email = editTextEmail.getText().toString().trim().toLowerCase();
    String birthday = editTextBirthday.getText().toString();
    String gender = "";
    int weight1 = noPickNumber1.getValue();
    String weight = String.valueOf(weight1);
    int height1 = noPickNumber2.getValue();
    String height = String.valueOf(height1);

    // using for loop to find selected hero gender
    for (int i = 0; i < userGender.size(); i++){

        if(i == 0){
            gender = userGender.get(i).trim();
        }
    }

    register(first,last,username,password,confirmpass,email,birthday,gender,weight,height);
```

Figure 7: Store user's personal information and transmit

```
if($first == '' || $superusername == '' || $superpassword == ''
|| $email == '' || $birthday == '' || $weight == '' || $height ==
''){
      echo 'please fill all values';
}
elseif($superpassword != $confirmpass){
      echo 'Password do not match!';
}
else{
      require_once('dbConnect.php');
      $sql = "SELECT * FROM user2 WHERE
superusername='$superusername' OR email='$email'";
      $check = mysqli_fetch_array(mysqli_query($con,$sql));
      if(isset($check)){
            echo 'username or email already exist';
      }else{
            $sql = "INSERT INTO user2
(first,last,superusername,superpassword,email,birthday,gender,wei
ght,height) VALUES
('$first','$last','$superusername','$superpassword','$email','$bi
rthday','$gender','$weight','$height')";
            if(mysqli_query($con,$sql)){
                  echo 'successfully registered';
            }else{
                  echo 'oops! Please try again!';
```

Figure 8: Verify all information before transmitting

id	first	last	email	superusername	superpassword	birthday	gender	weight	height
47	wesley	mcgowan	owmcgowa@mtu.edu	owmcgowa	123	13	Male	100	54

Figure 9: Insert new user's personal information

```
@Override
protected void onPostExecute(String s) {
    super.onPostExecute(s);
    loading.dismiss();
    if(s.equalsIgnoreCase("successfully registered")){
        Intent intent = new Intent(SignUp.this, SuperheroLogin.class);
        intent.putExtra(USER_NAME,username);
        startActivity(intent);
    }else{
        Toast.makeText(SignUp.this,s,Toast.LENGTH_LONG).show();
    }
}
```

Figure 10: Received message and send to Superhero Info screen

On the *Superhero Info* screen, the user will be asked to enter a superhero name, superhero gender, and pick three out of nine super powers. For example, the user may enter superhero name “Eibo”; superhero gender “male”; and superhero powers “Super Speed”, “Flight”, and “Duplication”. When the “Create Superhero” button is clicked, their superhero information is passed along to PHP *[Figure 11, 12]*. PHP will check for the following criteria and display a message if:

- Fail to fill superhero name and superhero gender – “Please fill all values”

- Fail to pick three powers – “Please pick 3 powers”

If superhero name, superhero gender, and three powers are selected, the superhero information will be passed to the database named “*logtest*” in table “*user2*” *[Figure 13]*. If successful, Java will receive a “success” message and the *Sidekick Info* screen will display *[Figure 14]*. If unsuccessful, the user will receive an “Error updating record:” message.

```
private void registerSuperhero() {
    String username = user;
    String superhero = editTextSuperhero.getText().toString();
    String superheroGender = "";

    String power1 = "";
    String power2 = "";
    String power3 = "";

    // using for loop to find selected hero powers
    for (int i = 0; i < selection.size(); i++) {

        if (i == 0) {
            power1 = selection.get(i).trim();
        }
        if (i == 1) {
            power2 = selection.get(i).trim();
        }
        if (i == 2) {
            power3 = selection.get(i).trim();
        }
    }
    // using for loop to find selected hero gender
    for (int j = 0; j < genderSP.size(); j++) {

        if (j == 0) {
            superheroGender = genderSP.get(j).trim();
        }
    }
    Superhero(username, superhero, superheroGender, power1, power2, power3);
```

Figure 11: Store superhero information and transmit

```
$superusername = $_GET['username'];
$superhero = $_GET['superhero'];
$supergender = $_GET['superheroGender'];
$power1 = $_GET['power1'];
$power2 = $_GET['power2'];
$power3 = $_GET['power3'];

if($superhero == '' || $supergender == ''){
echo 'please fill all values';
}

elseif($power1 == '' |$power2 == '' |$power3 == ''){
echo 'please pick 3 powers';
}

else{
$sql = "UPDATE user2 SET superhero = '$superhero', supergender =
'$supergender', power1 = '$power1', power2 = '$power2', power3 =
'$power3' WHERE superusername = '$superusername'";

if ($con->query($sql) === TRUE) {
    echo "success";
} else {
    echo "Error updating record: " . $con->error;
```

Figure 12: Verify superhero information before transmitting

superusername	superpassword	birthday	gender	weight	height	superhero	supergender	power1	power2	power3
owmcgowa	123	13	Male	100	54	Eibo	Male	Super_Speed	Flight	Duplication

Figure 13: Update patent "owmcgowa" superhero information

```
@Override
protected void onPostExecute(String s) {
    super.onPostExecute(s);
    loading.dismiss();
    if (s.equalsIgnoreCase("success")) {
        Intent intent = new Intent(SuperheroLogin.this, Sidekick.class);
        intent.putExtra(USER_NAME, username);
        startActivity(intent);
    } else {
        Toast.makeText(SuperheroLogin.this, s, Toast.LENGTH_LONG).show();
    }
```

Figure 14: Received message and send to Sidekick screen

The *Sidekick Info* screen is where a parent/guardian will input their information. A parent/guardian will have access to the user's data to help keep them honest as well as educated on their child condition. Parent/guardian would enter their name, username, password, and select one power. For example, the parent/guardian may enter name "Obie"; username "Obi"; password "123"; and power "X-Ray Vision". When the "Save Techville" button is clicked, their sidekick information is passed to a PHP *[Figure 15, 16]*. PHP will check for the following criteria and display a message if:

- Fail to fill sidekick name, username, password – "Please fill all values"
- Password and Confirm Password do not match – "Password do not match!"

- The username already exits – “Username already exist”
- Fail to pick one powers – “Please pick a powers”

If fields are filled correctly, the password and confirm passwords match, previously nonexistent username, and one power is selected, the sidekick’s information will be passed to the database name “*logtest*” in table “*skuser*” *[Figure 17]*. If successful, Java will receive a “success” message and the Home screen will display *[Figure 18, 19]*. If unsuccessful, user will receive an “oops! Please try again!” message.

```
Intent intent = getIntent();
String user = intent.getStringExtra(SuperheroLogin.USER_NAME);
String username = user;
String skname = editTextName.getText().toString().trim();
String skusername = editTextUsername.getText().toString().trim();
String skpassword = editTextPassword.getText().toString().trim();
String skconfirm = editTextConfirm.getText().toString().trim();
String skpower = "";

for (int i = 0; i < sidekickpower.size(); i++ ){
    if(i == 0){
        skpower = sidekickpower.get(i).trim();
    }
}
register(username, skname, skusername, skpassword, skconfirm, skpower);
```

Figure 15: Store sidekick information and transmit

```
if($skname == '' || $skusername == '' || $skpassword == ''){
      echo 'please fill all values';
}

elseif($skpassword != $skconfirm){
      echo 'Password do not match!';
}

elseif($skpower == ''){
      echo 'Please pick a power';
}

else{
      require_once('dbConnect.php');
      $sql = "SELECT * FROM skuser WHERE
skusername='$skusername'";
      $check = mysqli_fetch_array(mysqli_query($con,$sql));
      if(isset($check)){
            echo 'username already exist';
      }else{
            $sql = "INSERT INTO skuser
(username,skname,skusername,skpassword,skpower) VALUES
('$username','$skname','$skusername','$skpassword','$skpower')";
            if(mysqli_query($con,$sql)){
                  echo 'success';
            }else{
                  echo 'oops! Please try again!';
            }
```

Figure 16: Verify sidekick information before transmitting

id	username	skname	skusername	skpassword	skpower
14	owmcgowa	Obie	Obi	123	X-Ray_Vision

Figure 17: Insert sidekick information
Figure 10.3: Insert sidekick information

```
protected void onPostExecute(String s) {
    super.onPostExecute(s);
    loading.dismiss();
    if(s.equalsIgnoreCase("success")){
        Intent intent = new Intent(Sidekick.this, Home.class);
        intent.putExtra(USER_NAME,username);
        startActivity(intent);
    }else{
        Toast.makeText(Sidekick.this, s, Toast.LENGTH_LONG).show();
    }
```

Figure 18: Received message and send to Home screen

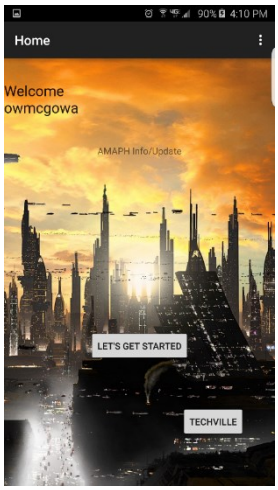


Figure 19: Home Screen [17]

The user's username, updates, and two buttons are displayed on the *Home* screen *[Figure 19]*. The user's username is displayed by Advance Monitoring Application of Personal Heath (AMAPH). AMAPH was designed to help users manage their condition by keeping them updated on their health status, current events (education and Techville) and other services they may need. If user click the "*Let's Get Started*" button, the

[17] Figure 19 background image: Futuristic City © Scott Richard, Source: Deviant Art, retrieved from http://rich35211.deviantart.com/art/Futuristic-City-169594723 [28]

AMAPH screen will display. If user click the "*Techville*" button, *Techville* screen will display. Techville is the entry point for the gamified side. On the *AMAPH* screen, users will have four options to choose from: "*Services*", "*Health Status*", "*Current Events*" or return "*Home*". The *Services* screen, shows the user most recent training percentage in the display. AMAPH does this by sending user username to a Java file *[Figure 20, 21]*. Java sends this information to the PHP to retrieve the latest updated percentage from the database "*logtest*" in table "*percentage*" *[Figure 22, 23]*. After querying the database, the date, time, and percentage is sent back to "*GetResult.java*" which is returned back to "*Services.java*" and displayed. If a query were to return "null" value for date, time, and percentage the "*Services*" screen would read "[username] your last entry was on: No information at this time".

```
private void getData(){

    String url = GetResult.DATA_URL+username.trim();

    StringRequest stringRequest = new StringRequest(url, (response) → {
            showJSON(response);
    },
            (error) → {
                    Toast.makeText(Services.this, error.getMessage().toString(), Toast.LENGTH_LONG).show();
            });
    RequestQueue requestQueue = Volley.newRequestQueue(this);
    requestQueue.add(stringRequest);
}

public void showJSON(String response) {
    percentage = "";
    date = "";
    time = "";

    try {
        JSONObject jsonObject = new JSONObject(response);
        JSONArray result = jsonObject.getJSONArray(GetResult.JSON_ARRAY);
        JSONObject resultData = result.getJSONObject(0);
        percentage = resultData.getString(GetResult.KEY_PERCENTAGE);
        date = resultData.getString(GetResult.KEY_DATE);
        time = resultData.getString(GetResult.KEY_TIME);

        update();

    } catch (JSONException e) {
        e.printStackTrace();
    }
```

Figure 20: Transmit username, receive and display user's training data

```
public class GetResult {

    public static final String DATA_URL = "http://141.219.187.99/log_in/getResult.php?username=";
    public static final String KEY_PERCENTAGE = "percentage";
    public static final String KEY_DATE = "date";
    public static final String KEY_TIME = "time";
    public static final String JSON_ARRAY = "result";
```

Figure 21: Request user's training data and store results

```
 if($_SERVER['REQUEST_METHOD']=='GET'){

 $username = $_GET['username'];

 require_once('dbConnect.php');

$sql = "SELECT percentage, date_format(Date(timestamp),'%b %d')
AS date, date_format(timestamp, '%h:%i %p') AS time from
percentage where username = '".$username."' AND timestamp =
(SELECT MAX(timestamp) from percentage) GROUP BY timestamp";

 $r = mysqli_query($con,$sql);

 $res = mysqli_fetch_array($r);

 $result = array();

 array_push($result,array(
 "percentage"=>$res['percentage'],
 "date"=>$res['date'],
 "time"=>$res['time']
 )
 );

 echo json_encode(array("result"=>$result));
```

Figure 22: Request user's last training entry and transmit data back

percentage	date	time
70	Mar 20	02:29 PM

Figure 23: Database entry

```
if (v == bTraining) {
    Intent i = new Intent(Services.this, Training.class);
    i.putExtra(USER_NAME, username);
    startActivity(i);
}

if (v == bServicesBackAMAPH) {
    Intent i = new Intent(Services.this, Amaph.class);
    i.putExtra(USER_NAME, username);
    startActivity(i);
```

Figure 24: Take the user to AMAPH or Training screen

The *Training* screen is where AMAPH has the user enter the following information: “Hours of Sleep” – max ten hours, “Minutes of Activity” – max of 60 minutes, “Servings of Bread” – max of nine for females, eleven for males, “Servings of Fruit” – max of four for females, five for males, “Servings of Vegetables” – max of three

for females, four for males, "Servings of Meat" – max of two for females, three for males, and "Servings of Milk" – max of three. AMAPH makes a query to the database to request the user's weight, height, gender and age *[Figure 25, 26, 27, 28]*. All four factors are dependent upon gender, age, height, and weight. AMAPH sends information to "Sleep" [22], "Activity" [23], "Food" [24], and "BMI" [25] to calculate each risk factor *[Figure 26]*. Sleep is calculated using the hours of sleep multiplying that number by three. Activity is based on the minutes of physical activity divided by two with a maximum of 60 minutes per day to decrease the risk of injury. Food is based on five subcategories including: bread (6%), vegetables (6%), fruit (6%), milk (6%), and meat (6%). BMI is based on the following equation:

$$\frac{weight\ in\ pounds}{height^2\ in\ inches} \times 703$$

AMAPH Training Calculation =

$$Sleep(30\%) + Activity(30\%) + Food(30\%) + BMI(10\%)$$

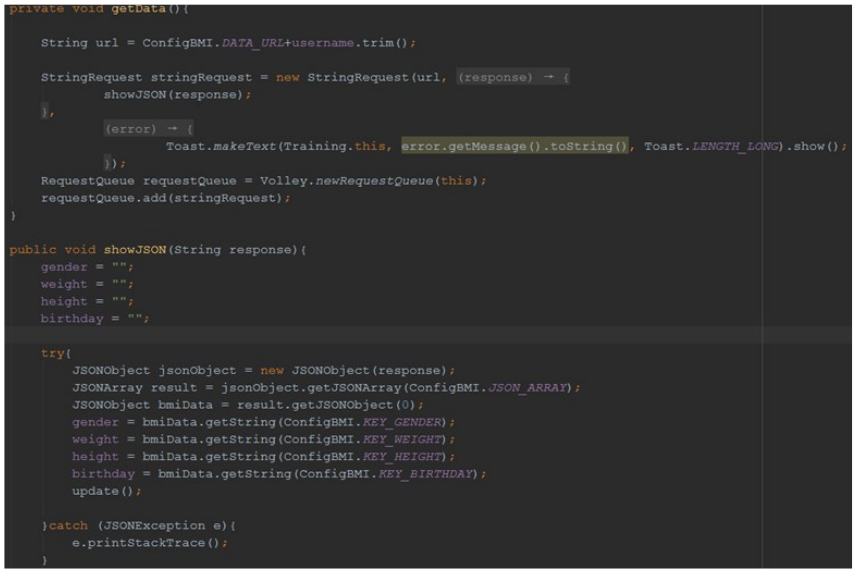
For example, a user may enter: sleep 9, activity 50, bread 8, fruit 3, vegetable 4, meat 2 and milk 2. AMAPH querying the database for username "owmcgowa" and learns that "owmcgowa" personal information is weight 100, height 54, age 13, and gender male. Based on the information the BMI percentage for owmcgowa was determined to be 4 using the following equation:

$$\frac{100}{54^2} x\ 703 = 24.1083676269$$

This number is sent to *BMI.java* to calculate percentage *[Appendix C]*. Sleep percentage is 27 using the following equation: $9\ x\ 3 = 27$. Activity percentage is 25

using the following equation: $50/2 = 25$. Bread, fruit, vegetable, meat, and milk percentage are 4.8, 4.5, 4.8, 4.0662, and 4.0662 respectively *[Appendix C]*. Food percentage is 22.23 by adding bread, fruit, vegetable, meat and milk together. User owmcgowa's risk score is 78% by adding BMI, Sleep, Activity, and Food.

AMAPH Training Calculation: 4 + 27 + 25 + 22.23 = 78%. The results of the AMAPH Training Calculation are sent to the "Training Result" screen. Based on the four risk factors there are three categories of scores in the algorithm: high risk is 0 – 64% will develop Type-2 diabetes within five years, moderate risk is 65 – 84% will develop Type-2 diabetes within five to ten years, and low risk is 85 – 100% will prolong from developing Type-2 diabetes. The user "owmcgowa" falls into the moderate risk category.



```
private void getData(){

    String url = ConfigBMI.DATA_URL+username.trim();

    StringRequest stringRequest = new StringRequest(url, (response) → {
            showJSON(response);
    },
            (error) → {
                    Toast.makeText(Training.this, error.getMessage().toString(), Toast.LENGTH_LONG).show();
            });
    RequestQueue requestQueue = Volley.newRequestQueue(this);
    requestQueue.add(stringRequest);
}

public void showJSON(String response){
    gender = "";
    weight = "";
    height = "";
    birthday = "";

    try{
        JSONObject jsonObject = new JSONObject(response);
        JSONArray result = jsonObject.getJSONArray(ConfigBMI.JSON_ARRAY);
        JSONObject bmiData = result.getJSONObject(0);
        gender = bmiData.getString(ConfigBMI.KEY_GENDER);
        weight = bmiData.getString(ConfigBMI.KEY_WEIGHT);
        height = bmiData.getString(ConfigBMI.KEY_HEIGHT);
        birthday = bmiData.getString(ConfigBMI.KEY_BIRTHDAY);
        update();

    }catch (JSONException e){
        e.printStackTrace();
    }
```

Figure 25: Transmit username, receive user's information

```
int sleep1 = Integer.parseInt(sleep.getText().toString());
sleepTime.setSleepFinal(sleep1);

//Activity
Activity activityTime = new Activity();
int act1 = Integer.parseInt(act.getText().toString());
activityTime.setActivityFinal(act1);

//BMI
BMI bmi = new BMI();
double weight1 = Integer.parseInt(weight);
double height1 = Integer.parseInt(height);
double bmitest = ((weight1 / (height1 * height1)) * 703);
double ageF = Integer.parseInt(birthday);
String sexF = gender;
bmi.setBmiFinal(sexF, ageF, bmitest);

//Food
Food food = new Food();
double bread1 = Integer.parseInt(bread.getText().toString());
double veg1 = Integer.parseInt(veg.getText().toString());
double fruit1 = Integer.parseInt(fruit.getText().toString());
double milk1 = Integer.parseInt(milk.getText().toString());
double meat1 = Integer.parseInt(meat.getText().toString());
food.setBreadFinal(bread1, sexF);
food.setVegetableFinal(veg1, sexF);
food.setFruitFinal(fruit1, sexF);
food.setMilkFinal(milk1);
food.setMeatFinal(meat1, sexF);
double foodAll = food.getBreadFinal() + food.getVegetableFinal() + food.getFruitFinal() + food.getMilkFinal() + food.getMeatFinal();
food.setFoodFinal(foodAll);

//add everything
double all = sleepTime.getSleepFinal() + activityTime.getActivityFinal() + bmi.getBmiFinal() + food.getFoodFinal();
int numberF = (int) all;
//System.out.println(weight1 + " " + height1 +" "+ageF + " " + sexF + " " + numberF);

numberFinal(numberF);
```

Figure 26: Transmit user's input, receive training results

```
public static final String DATA_URL = "http://141.219.187.99/log_in/getBMI.php?username=";
public static final String KEY_GENDER = "gender";
public static final String KEY_WEIGHT = "weight";
public static final String KEY_HEIGHT = "height";
public static final String KEY_BIRTHDAY = "birthday";
public static final String JSON_ARRAY = "result";
```

Figure 27: Request user's information and store results

```
if($_SERVER['REQUEST_METHOD']=='GET'){

$username = $_GET['username'];

require_once('dbConnect.php');

$sql = "select gender, weight, height, birthday FROM user2 WHERE
superusername = '".$username."'";

$r = mysqli_query($con,$sql);

$res = mysqli_fetch_array($r);

$result = array();

array_push($result,array(
"gender"=>$res['gender'],
"weight"=>$res['weight'],
"height"=>$res['height'],
"birthday"=>$res['birthday']
)
);

echo json_encode(array("result"=>$result));
```

Figure 28: Request user's information and transmit data

On the Training Result screen, AMAPH Training Calculation is displayed with some words of encouragement. Depending on the percentage display one of five messages could be display. The five possible messages are: percentage between 81 – 100 – "Congratulations! You are becoming a MASTER, stay focused!"; percentage between 61 – 80 – "Congrats! You have shown much potential, but still need to improve."; percentage between 41 – 60 – "Nice Work! Keep improving to reach master Superhero status."; percentage between 21 – 40 – "Good Effort! However, you have much more to learn young Superhero"; and percentage between 0 – 20 – "A key to a young Superhero's success is patience, effort, training, and focus. Keep going and believe in your potential."

As users take damage from encountering villains in Techville, their armor will slow fade away to reveal their face. A user has another opportunity to learn about their condition and how to prevent or prolong becoming a Type-2 diabetic on the *Current Events* screen. This screen delivers educational facts in set of three, to users with updates about Dr. Sweet-tooth and his henchman in Techville. One possible scenario for user "owmcgowa": AMAPH has sent you an important message saying Insomnia is trying to take over Techville by keeping everybody awake. The people of Techville need your help. Let's save Techville from Insomnia by clicking on the "Techville" button. A storyline about how Techville is falling under the Insomnia spell will play. In the storyline AMAPH describes how Insomnia is terrorizing people by keeping the awake, as well as educated the user on ways to stop Insomnia tyranny.

Insomnia is keeping people awake by making them play video games, watching television, eating, partying, and causing people to have messy bedrooms. Insomnia can

be defeated by turning off all distractions before bed, getting ten hours of sleep, cleaning your room, and avoiding eating late at night. Now the user is ready to take on Insomnia and Dr. Sweet-Tooth on the Encounter screen *[Figure 29]*. AMAPH has a power meter that represents a user's latest training results, their three powers, and the sidekick power.

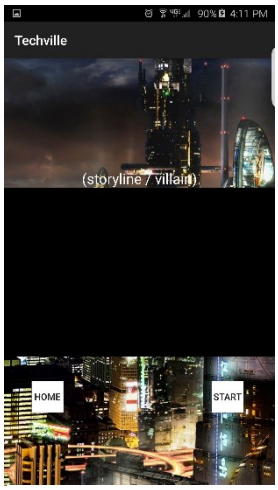


Figure 29: Techville Storyline Screen

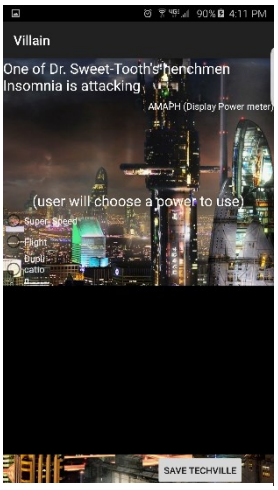


Figure 30: Encounter Screen

[18]

The user "owmcgowa" uses their sidekick power "X-Ray Vision" to locate Insomnia in an abandoned building five blocks down. The user uses their "Duplication" power to help people clean up and to surround Insomnia. After surrounding Insomnia "owmcgowa" uses their "Super Speed" to subdue Insomnia. Once again Techville can sleep safe and sound knowing that Insomnia is safely behind bars. The evil Dr. Sweet-tooth and his henchmen will return but until then a superhero name "Eibo" will be waiting. After Techville is saved, the user will return back to the *Home* screen. From here, the user

[18] Figure 29 and 30 background image: ACTMM Matte 5 © Scott Richard, Source: Deviant Art, retrieved from http://rich35211.deviantart.com/art/ACTMM-Matte-5-264617714 [29]

could also update their information on the "Update" screen. The Update screen will give the user the ability to update their email, weight, and height when necessary.

Results

A survey was conducted to test the proof of concept[19] for a gamified mobile application for disease management to assist pre-diabetic adolescents. To test this proof of concept three physicians were selected to interact with the application. After using the application, the physicians were asked to take a survey detailing their experiences [Appendix D]. The results from the survey show that the physicians agree that this application is helpful, but remained neutral about its early development design.

Physician Demographics

Question 1 – 6 asks questions that determine the demographic background of the physicians. Based on the responses it was determined that 66.7% had worked in the health sector between 1 – 5 years. Whereas one physician (33.3%) had worked in the field from 6 – 10 years. The majority of the physicians tested were new to the field and this may have an impact on their willingness to engage new technology to treat their users. All of the physicians stated that they own smartphones and use health oriented applications. In a given week, the least amount of time they use these types of applications is twice a week. This knowledge of the physician's behavior shows that they

[19] The pre-diabetes gamified application was a proof of concept.

are comfortable using smart phone applications to assist them in their own healthcare management.

Educational Design and Response

Questions 7 – 16 asked the physicians questions about their interactions with the application. Based on question 7, the physicians do not feel that users have prior knowledge of childhood diabetes. In question 8, they stated that they believe that this type of application could help users learn more about childhood diabetes. In question 10 the physicians recognize that the application is still in the development stages, but suggest updating the current events section, the training section, and merging data for hospital utilization. Physicians' suggest updating the current events section to include more relevant maintenance information for childhood diabetes. It was suggested that the training section be updated to include pictures instead of text. Suggestions for the hospital utilization portion include allowing the data collected to be merged into existing hospital user management records. The physician's remained neutral on the application's ability to improve user follow up of clinical appointments. Overall the physician's thoughts about this application are in a range of 'agree' to 'neutral' concerning the benefits of using this type of application as a preventive measure against diabetes with adolescents.

Conclusion

The current culture within North America encourages adolescents to interact with technology on a grand scale. With 88% of all American adolescents have or have access to a mobile phone, and 81% of adolescents have access to a gaming console [11]. Based

on the current technological culture of North American youth the goals of this project were to:

- Develop a prototype mobile application to capture, track, and analyze adolescent health data
- Develop technology games aimed at improving health
- Develop mobile applications that will be beneficial to both users and the clinicians

The focus for this application was to prevent or prolong adolescents from becoming Type-2 diabetics in lower income and rural areas. We attempted to do this by developing educational tools and resources that promote healthy living though a gamified mobile application. Diabetes affects 380 million people and claims the life of one American every three minutes [26]. Based on these statistics it is apparent that Diabetes has a major impact on the people of North America. Being aware of pre-diabetes can allow a person to reduce their risk for developing Type-2 diabetes by 58% [8, 17, 21]. In an effort to reduce these findings we developed a proof of concept gaming application to assist pre-diabetic adolescent youths.

Due to time constraints this application was only tested for its validity in assisting pre-diabetic adolescents with self-management. Results show that there is a need for these types of self-management applications in this technology driven society. It also has the ability to educate adolescents and their parents/guardians about pre-diabetes to help reduce the development of Type 2 Diabetes. Future work includes a deployment of the application to multiple platforms. This will include: updating the application for adults,

developing health status pages to include user face pictures with armor overlays, developing a well-developed storyline, and expanding the educational health library.

A proposed study will consist of two parts: a clinical visit and the mobile application. Each volunteer who is a pre-diabetic adolescent will be tested every month for a six-month period. This application will also prompt reminders to the user about appointments, award the user for physical activity and sleep habits, and update information on their progress. This study will focus on adolescents ages 12 to 19 years old, with a sample size of 30 volunteers. Of the 30 volunteers, 15 will have access to the mobile application and the other 15 will not. In each visit, the user's height, weight, waist circumference, body fat, blood pressure, glucose levels and cholesterol will be recorded. The application will allow users to input their diet, physical activity, and sleep pattern. As part of the mobile application, the user will be given an actical accelerometer to be worn on their wrist in order to monitor the user's physical activity and sleeping habits. With tablets and smart phones being provided as learning tools for the youth of today, it is our belief that mobile app will aid in the future development of better diabetic management in adolescents.

References

[1] Aguiree, Florencia, et al. "IDF diabetes atlas." (2013).

[2] Centers for Disease Control and Prevention. "National diabetes statistics report: estimates of diabetes and its burden in the United States, 2014."Atlanta, GA: US Department of Health and Human Services (2014).

[3] The Directors of Health Promotion and Education. "Diabetes Risk Factors Community Profile Upper Peninsula." Michigan Diabetes Prevention Network (2013). Web.

[4] "Statistics about Diabetes." American Diabetes Association. American Diabetes Association, 1 Jan. 2014. Web. 10 Apr. 2015.

[5] Atla, Ana İçeriğe. "Prediabetes in Children and Adolescents: What Does It Mean?." 2 Jan. 2013.

[6] American Diabetes Association. "Diagnosis and classification of diabetes mellitus." Diabetes care 36.Supplement 1 (2013): S67-S74.

[7] World Health Organization. "Global status report on noncommunicable diseases 2014." (2014).

[8] The National Institute of Diabetes and Digestive and Kidney Diseases. "Diagnosis of Diabetes and Prediabetes." Diagnosis of Diabetes and Prediabetes. The National Institute of Diabetes and Digestive and Kidney Diseases, June 2014. Web. 11 Apr. 2015.

[9] Centers for Disease Control and Prevention (CDC), and Centers for Disease Control and Prevention (CDC). "National diabetes fact sheet: national estimates and general information on diabetes and prediabetes in the United States, 2011." Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention 201 (2011).

[10] Beaser, Richard S. The Joslin guide to diabetes: A program for managing your treatment. Simon and Schuster, 2008.

[11] Lenhart, Amaanda "Teens, Social Media, and Technology Overview 2015." *Pew Research Center Internet, Science & Tech*. Pew Research Center. April 9, 2015.

[12] Sproutel. "Meet Jerry the Bear." *Jerry the Bear*. Web. 15 Apr. 2015.

[13] Game Equals Life. "The Magi and The Sleeping Star." *Kickstarter*. Web. 16 Apr. 2015.

[14] Baranowski, Tom et al. "Video Game Play, Child Diet, and Physical Activity Behavior Change: A Randomized Clinical Trial." American journal of preventive medicine 40.1 (2011): 33–38.

[15] Cavanagh, Natasha. "The Implementation of an Android Mobile Application for the Management of Type 1 Diabetes Treatment." 14 May 2014.

[16] Portage Health. "Pre-diabetes Screening." Telephone interview. 1 Feb. 2015.

[17] Diabetes Prevention Program Research Group. "10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study." The Lancet 374.9702 (2009): 1677-1686.

[18] Gartner. "Number of Smartphones Sold to End Users Worldwide from 2007 to 2015 (in Million Units)." Statista - The Statistics Portal. Statista. February 2016.

[19] Tran, Joseph, Rosanna Tran, and John R. White, Jr. "Smartphone-based glucose monitors and applications in the management of diabetes: an overview of 10 salient 'apps' and a novel smartphone-connected blood glucose monitor." Clinical Diabetes 30.4 (2012): 173+.

[20] American Diabetes Association. "Insulin Basics." American Diabetes Association. American Diabetes Association, 16 July 2015. Web. 07 Feb. 2016.

[21] Diabetes Prevention Program (DPP) Research Group. "The Diabetes Prevention Program (DPP) description of lifestyle intervention." Diabetes care 25.12 (2002): 2165-2171.

[22] Patlak, Margie. Your guide to healthy sleep. US Department of Health and Human Services, 2005.

[23] U.S Department of Health and Human Services, and Centers for Disease Control and Prevention. Guidelines for School and Community Programs to Promote Lifelong Physical Activity Among Young People. Rep. no. RR-6. Vol. 46. Morbidity and Mortality Weekly Report. 7 Mar. 1997. Print.

[24] U.S. Department of Health and Human Services, and Centers for Disease Control and Prevention. Guidelines for School Health Programs to Promote Lifelong Healthy Eating. Rep. no. RR-9. Vol. 45. Morbidity and Mortality Weekly Report. 14 Jun. 1996. Print.

[25] Department of Health and Human Services, Centers for Disease Control and Prevention, and National Center for Health Statisitcs. "2000 CDC Growth Charts for the United States: Methods and Development." Vital and Health Statistics 11th ser. (May 2002). Web.

[26] Diabetes Research Institute Foundation. "What Is Diabetes?" Diabetes Research Institute Foundation. Diabetes Research Institute Foundation, 2016. Web. Jan. 2016.

[27] Richard, Scott. *Futuristic City* 3. Oct. 2011. Deviant Art. Deviant Art, Oct. 2011. Web. Feb. 2016.

[28] Richard, Scott. *Futuristic City*. Oct. 2011. Deviant Art. Deviant Art, Oct. 2011. Web. Feb. 2016.

[29] Richard, Scott. *ACTMM Matte 5*. Oct. 2011. Deviant Art. Deviant Art, Oct. 2011. Web. Feb. 2016.

Appendix A

AMAPH Training Calculation

Food Calculation:

Table 1: Bread Servings

Bread Servings			
Female	Percentage	Male	Percentage
9	100	11	100
7 – 8	80	8 – 10	80
5 – 6	60	5 – 7	60
3 – 4	40	2 – 4	40
1 – 2	20	1	20
0	0	0	0

Table 2: Fruit Servings

Fruit Servings			
Female	Percentage	Male	Percentage
3	100	4	100
2	67.67	3	75
1	34.34	2	50
0	0	1	25
		0	0

Table 3: Meat Servings

Meat Servings			
Female	Percentage	Male	Percentage
2	100	3	100
1	50	2	66.67
0	0	1	34.34
		0	0

Table 4: Milk Servings

Milk Servings			
Female	Percentage	Male	Percentage
3	100	3	100
2	66.67	2	66.67
1	34.34	1	34.34
0	0	0	0

Table 5: Vegetable Servings

Vegetable Servings			
Female	Percentage	Male	Percentage
4	100	5	100
3	75	4	80
2	50	3	60
1	25	2	40
0	0	1	20
		0	0

BMI Calculation:

Males

Table 6: Male BMI 8-9 years old

8 years old		Percentage	9 years old		Percentage
Below 13.80	Underweight	4	Below 14.00	Underweight	4
13.81 – 18.00	Normal	10	14.01 – 18.40	Normal	10
18.01 – 20.00	Overweight	4	18.41 – 21.00	Overweight	4
Above 20.01	Obese	2	Above 21.01	Obese	2

Table 7: Male BMI 10-11 years old

10 years old		Percentage	11 years old		Percentage
Below 14.20	Underweight	4	Below 14.60	Underweight	4
14.21 – 19.40	Normal	10	14.61 – 20.20	Normal	10
19.41 – 22.00	Overweight	4	20.21 – 23.20	Overweight	4
Above 22.01	Obese	2	Above 23.21	Obese	2

Table 8: Male BMI 12-13 years old

12 years old		Percentage	13 years old		Percentage
Below 15.00	Underweight	4	Below 15.40	Underweight	4
15.01 – 21.00	Normal	10	15.41 – 21.80	Normal	10
21.01 – 24.20	Overweight	4	21.80 – 25.20	Overweight	4
Above 24.21	Obese	2	Above 25.21	Obese	2

Table 9: Male BMI 14-15 years old

14 years old		Percentage	15 years old		Percentage
Below 16.00	Underweight	4	Below 16.60	Underweight	4
16.01 – 22.60	Normal	10	16.61 – 23.40	Normal	10
22.61 – 26.00	Overweight	4	23.41 – 26.80	Overweight	4
Above 26.01	Obese	2	Above 26.81	Obese	2

Table 10: Male BMI 16-17 years old

16 years old		Percentage	17 years old		Percentage
Below 17.20	Underweight	4	Below 17.60	Underweight	4
17.21 – 24.20	Normal	10	17.61 – 25.00	Normal	10
24.21 – 27.60	Overweight	4	25.01 – 28.20	Overweight	4
Above 27.61	Obese	2	Above 28.21	Obese	2

Table 11: Male BMI 18-19 years old

18 years old		Percentage	19years old		Percentage
Below 18.20	Underweight	4	Below 18.80	Underweight	4
18.21 – 25.60	Normal	10	18.81 – 26.40	Normal	10
25.61 – 29.00	Overweight	4	26.41 – 29.60	Overweight	4
Above 29.01	Obese	2	Above 29.61	Obese	2

Table 12: Male BMI 20 years old

20 years old		Percentage
Below 19.20	Underweight	4
19.21 – 27.00	Normal	10
27.01 – 30.60	Overweight	4
Above 30.61	Obese	2

Females

Table 13: Female BMI 8-9 years old

8 years old		Percentage	9 years old		Percentage
Below 13.60	Underweight	4	Below 13.80	Underweight	4
13.61 – 18.20	Normal	10	13.81 – 19.00	Normal	10
18.21 – 20.60	Overweight	4	19.01 – 21.80	Overweight	4
Above 20.61	Obese	2	Above 21.81	Obese	2

Table 14: Female BMI 10-11 years old

10 years old		Percentage	11 years old		Percentage
Below 14.00	Underweight	4	Below 14.40	Underweight	4
14.01 – 20.00	Normal	10	14.41 – 20.80	Normal	10
20.01 – 23.00	Overweight	4	20.81 – 24.00	Overweight	4
Above 23.01	Obese	2	Above 24.01	Obese	2

Table 15: Female BMI 12-13 years old

12 years old		Percentage	13 years old		Percentage
Below 14.80	Underweight	4	Below 15.20	Underweight	4
14.81 – 61.60	Normal	10	15.21 – 22.60	Normal	10
21.61 – 25.20	Overweight	4	22.60 – 26.20	Overweight	4
Above 25.21	Obese	2	Above 26.21	Obese	2

Table 16: Female BMI 14-15 years old

14 years old		Percentage	15 years old		Percentage
Below 15.80	Underweight	4	Below 16.20	Underweight	4
15.81 – 23.20	Normal	10	16.21 – 24.00	Normal	10
23.21 – 27.20	Overweight	4	24.01 – 28.00	Overweight	4
Above 27.21	Obese	2	Above 28.01	Obese	2

Table 17: Female BMI 16-17 years old

16 years old		Percentage	17 years old		Percentage
Below 16.80	Underweight	4	Below 17.20	Underweight	4
16.81 – 24.60	Normal	10	17.21 – 25.20	Normal	10
24.61 – 28.80	Overweight	4	25.21 – 29.80	Overweight	4
Above 28.81	Obese	2	Above 29.81	Obese	2

Table 18: Female BMI 18-19 years old

18 years old		Percentage	19years old		Percentage
Below 17.60	Underweight	4	Below 17.80	Underweight	4
17.61 – 25.60	Normal	10	17.81 – 26.00	Normal	10
25.61 – 30.20	Overweight	4	26.01 – 31.00	Overweight	4
Above 30.21	Obese	2	Above 31.01	Obese	2

Table 19: Female BMI 20 years old

20 years old		Percentage
Below 17.80	Underweight	4
17.81 – 26.40	Normal	10
26.41 – 31.80	Overweight	4
Above 31.81	Obese	2

Appendix B

Preventive Diabetes Application

1. What is your current position or title?

2. How many years have you worked in the health sector?
   - Less than one year
   - 1-5 years
   - 6-10 years
   - 10-15 year
   - More than 15 years

3. In a given week, how often do you use the applications on your smartphone?

   Never| 1 2 3 4 5 |Everyday

4. Does your smartphone contain any health-oriented applications?
   - Yes
   - No

5. If yes to the previous question, how often do you access these health-oriented applications in a given week?

   Never| 1 2 3 4 5 |Everyday

6. How important is the self-management of your health to you?

   Not Important | 1 2 3 4 5 |Extremely Important

7. Prior to your users using the application, on average, how would you rate your user's knowledge of childhood diabetes?

   No knowledge| 1 2 3 4 5 6 7 8 9 10 |Very Informed

8. Do you believe this application will help your users better understand the medical condition of childhood diabetes?

   No| 1 2 3 4 5 |Provides Significant Understanding

9. Is the design of this application easy to navigate?

I find it difficult to navigate within the application	1 2 3 4 5	The application is very easy to navigate

10. What recommendation or alterations world you suggest to improve the application?

11. Did you encounter any errors or bugs in the application?
    - Yes
    - No

12. If yes to the previous question, please explain which bugs or errors were found.

13. How much time (e.g. hours) would you estimate of evaluating this application?

14. I feel this application will help improve users' attendance in their follow-up clinical appointments.

    Strongly Agree| 1 2 3 4 5 |Strongly Disagree

15. I feel this application will help users improve preventive measures against diabetes.

    Strongly Agree| 1 2 3 4 5 |Strongly Disagree

16. Overall, how would you rate this application?
    - Very unsatisfied
    - Unsatisfied
    - Average
    - Satisfied
    - Very Satisfied
    - Other

Survey Results

What is your current position or title?

Primary Care Physician

Primary Care physician in Michigan

Brazilian Cardiologist Physician

How many years have you worked in the health sector?

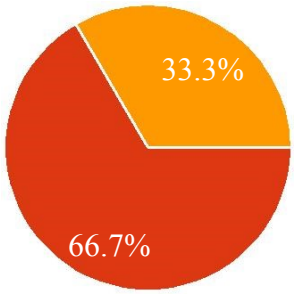


Figure 31: Years in the health sector

Less than one year	0	0%
1-5 years	2	66.7%
6-10 years	1	33.3%
10-15 year	0	0%
more than 15 years	0	0%

In a given week, how often do you use the applications on your smartphone?

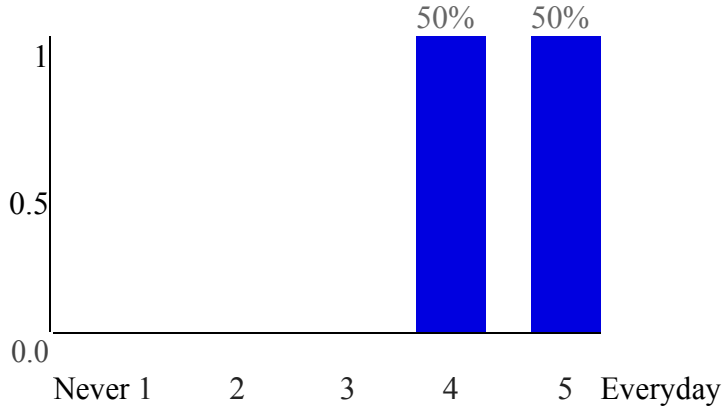


Figure 32: Use of smartphone applications

Does your smartphone contain any health oriented applications?

Yes	2	100%
No	0	0%

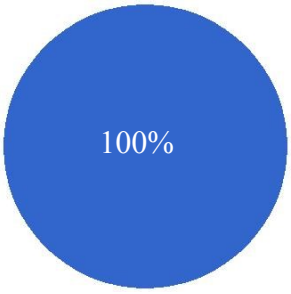


Figure 33: Health oriented applications

If yes to the previous question, how often do you access these health oriented applications in a given week?

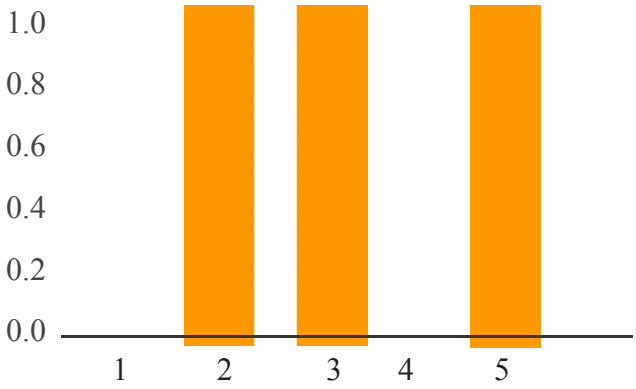


Figure 34: Rate of using the applications

Never:	1	0	0%
	2	1	33.3%
	3	1	33.3%
	4	0	0%
Every day:	5	1	33.3%

How important is the self-management of your health to you?

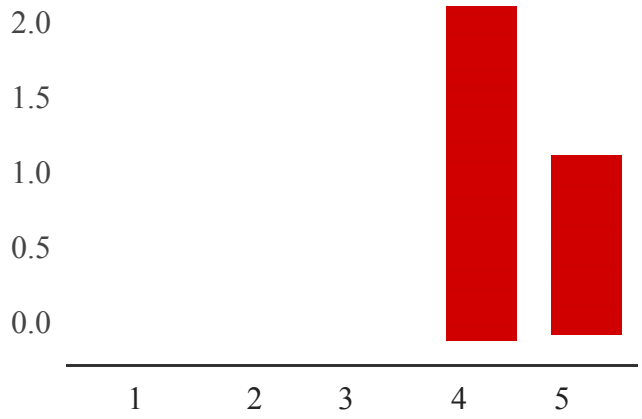


Figure 35: Health importance

Not important:	1	0	0%
	2	0	0%
	3	0	0%
	4	2	66.7%
Extremely important:	5	1	33.3%

Prior to your users using the application, on average, how would you rate your users' knowledge of childhood diabetes?

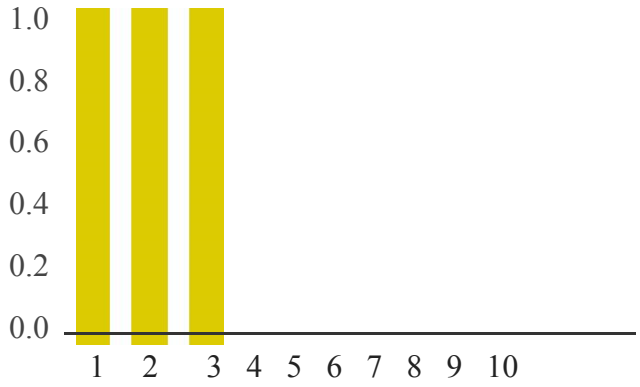


Figure 36: User Knowledge

No Knowledge:	1	1	33.3%
	2	1	33.3%
	3	1	33.3%
	4	0	0%
	5	0	0%
	6	0	0%
	7	0	0%
	8	0	0%
	9	0	0%
Very Informed:	10	0	0%

Do you believe this application will help your users better understand the medical condition of childhood diabetes?

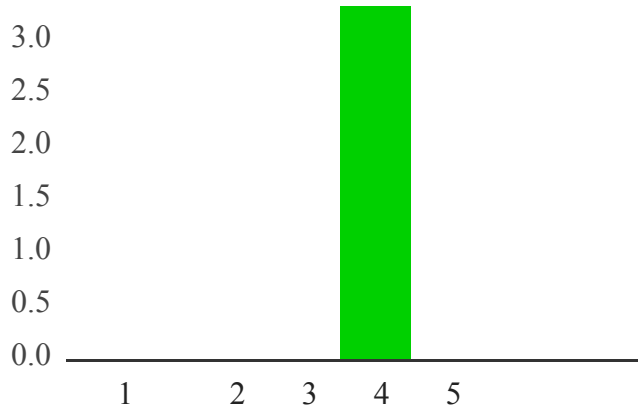


Figure 37: Understanding of childhood diabetes

No:	1	0	0%
	2	0	0%
	3	0	0%
	4	3	100%
Provides significant understanding:	5	0	0%

Is the design of this application easy to navigate?

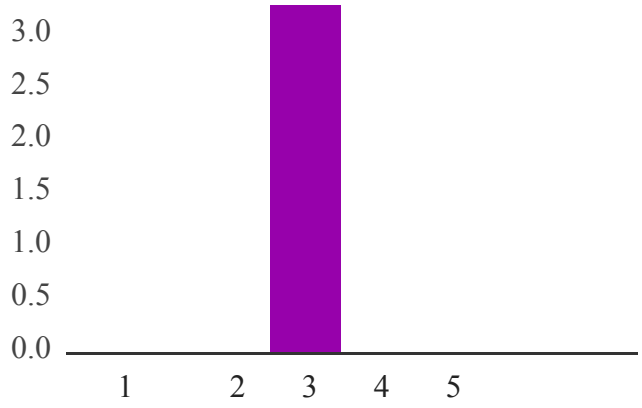


Figure 38: Easy of navigating

I find it difficult to navigate within the application:	1	0	0%
	2	0	0%
	3	3	100%
	4	0	0%
The application is very easy to navigate:	5	0	0%

What recommendation or alterations would you suggest to improve the application?

Several things on the application do not seem to working properly or have not yet to be developed. This is confusing.

Current Events - seems mislabeled as it represents more of health education.

Training section - could benefit from pictures accompanied by text for "hours of sleep" for example. Also, would be easier to scroll down to desired range rather than type it in.

Application seems incomplete. Lots of blanks. In Training section page does not disclose graph's prediction. What time is estimated if user receives 67%? I think this would be confusing to user and family. Is this data merged with other medical data from hospital? If not, perhaps you should consider for more effective analytics.

Did you encounter any errors or bugs in the application?

Figure 39: Errors or bugs

Yes	0	0%
No	3	100%

If yes to the previous question, please explain which bugs or errors were found.

How much time (e.g. hours) would you estimate of evaluating this application?

Answers from respondents:

- 2 hours
- Little under 1 hour
- 2 1/2 hours

I feel this application will help improve users' attendance in their follow-up clinical appointments.

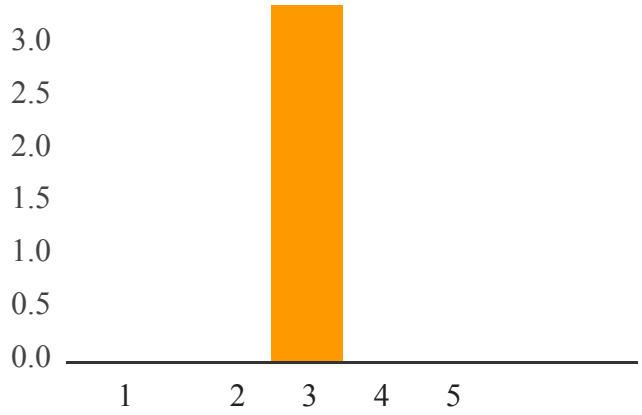


Figure 40: Clinical appointments

Strongly agree:	1	0	0%
	2	0	0%
	3	3	100%
	4	0	0%
Strongly disagree:	5	0	0%

I feel this application will help users improve preventive measures against diabetes.

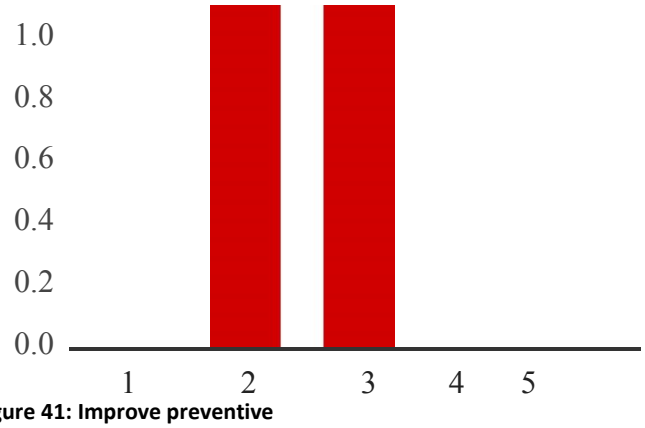


Figure 41: Improve preventive

Strongly agree:	1	0	0%
	2	1	50%
	3	1	50%
	4	0	0%
Strongly disagree:	5	0	0%

Overall, how would you rate this application?

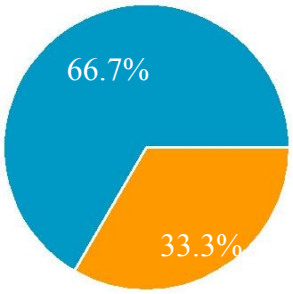


Figure 42: Rating of the application

Very unsatisfied	0	0%
Unsatisfied	0	0%
Average	1	33.3%
Satisfied	0	0%
Very Satisfied	0	0%
Other	2	66.7%

Number of daily responses

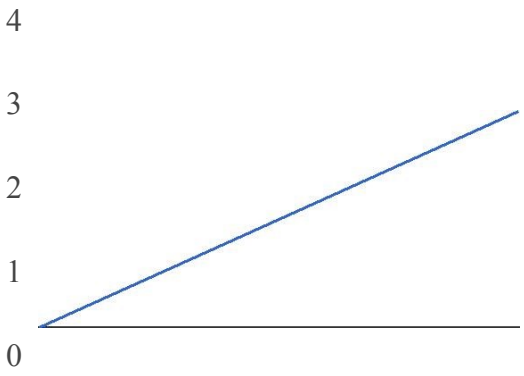


Figure 43: Responses