University of Southampton

Faculty of Physical and Applied Sciences

Electronics and Computer Science

A Gamified Management Tool and Community for Arab Diabetic Patients

by

Alaa Abdullah Al Marshedi

6 September 2013

A dissertation submitted in partial fulfilment of the degree of

MSc Web Technology

by examination and dissertation

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Abstract

The changes in diet and life style of today's community have resulted in many illnesses. One of the most common illnesses of the twentieth century is diabetes mellitus. The latest studies estimate a dramatic increase in diabetes cases in the Middle East. Saudi Arabia and other Arab countries are currently on the list of the top 10 countries which are most prevalent to diabetes. Living a long and healthy life with diabetes is possible. However, it requires a great deal of care and management of several aspects of the patient's life. This management ranges from keeping a record of one's glucose levels and associated information, to having the emotional and social support that they need to cope with the condition. Furthermore, as technology advances, more online tools and sources are available for users to use. These tools could help users to track and record their tests and spot any alarming patterns in their daily diet. The Internet also has many forums and groups that provide both knowledge and support to users. Unfortunately, even though the number of Arab patients is high and is dramatically increasing, such resources are not available to them in their own language. Thus, this dissertation proposes a solution to this problem. A web-based system named Sukr, which means both sugar and diabetes in Arabic, is designed and implemented to be both a social network and a management tool for Arab diabetic patients. This web-based system differs from any other similar Arab project for diabetes. One of its main features is the use of game designs and techniques to reinforce positive behavior in managing diabetes. Game techniques are also used to increase users' interaction in the community and to encourage users to exchange experiences and knowledge and provide emotional support to each other. The system was implemented using Drupal, which is an open source content management system. Furthermore, diabetologists and a psychologist evaluated the system and provided their valuable input, which is derived from years of experience gained from treating diabetic patients. Diabetic users also evaluated the system and provided a very positive set of responses. The vast majority of the users believed that the system would be very helpful to them in managing their condition.

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Chapter 1. Introduction:

One of the most common chronic illnesses today is diabetes mellitus. It is rapidly spreading among both the young and old and is considered by many to be the disease of the 21st century [Engelgau *et al.* 2003]. Many factors contribute to this widespread emergence of diabetes. These include population growth, urbanization, socioeconomic developments and the changes in lifestyle [Wild *et al.* 2004]. Diabetes affects the glucose level in the blood. Patients could suffer from hyperglycemia or/and hypoglycemia [Loader *et al.* 2002].

According to the International Diabetes Federation (IDF)[1], more than 371 million people have diabetes around the world. The Middle East contributes a lot to that number. Furthermore, the prevalence of diabetes in the world and especially in Arab countries is on the rise. These numbers are alarming and represent a major public health concern. Furthermore, if diabetes is left untreated or is not properly managed, it can lead to devastating complications. These include cardiovascular disease, kidney failure, blindness and amputations [American Diabetes Association 2013]. Diabetes does not only affect the body parts of patients, but it also could lead to clinical depression. It has been proven that patients with diabetes are more prone to depression than others [Egede *et al.* 2002].

1.1 The Problem Definition:

The number of diabetic people in the Arab world is rapidly increasing, and has been termed an epidemic. However, web-based management tools and communities are very rare. Furthermore, uncontrolled diabetes could lead to serious complications and sometimes it could lead to death. Patients must keep track of their blood glucose levels and maintain a healthy diet.

1.2 Proposed Solution:

One solution which is proposed is to incorporate behavioral insights with gaming techniques to provide an effective management tool for users. This is done through employing the principles of engagement, reward and motivation to certain tasks [Law *et al.* 2011]. On top of that, the proposed solution aims at fulfilling the emotional and social support that diabetic patients need by providing a community for them [Madara 1997]. In addition to being a source of emotional and social support, it will be a source of knowledge to Arab patients.

1.2.1 Project Goals:

The project aims to create a web-based management tool and a community for Arab diabetic patients. At the core of this project is implementation of gamification, which is the use of game techniques and principles, to assist patients in managing their condition and reinforce positive behavior. Furthermore, the system should provide the user with an electronic logbook for their tests. It should also allow users to visualize their progress by presenting these test results in a graph form. This will help them recognize patterns in their condition.

[1] http://www.idf.org/diabetesatlas/5e/Update2012

[2] http://www.idf.org/diabetesatlas/5e/the-global-burden

Chapter 2. Literature Review and Background Research

2.1 Diabetes:

The changes in our lifestyle and diet have led to increasing numbers of illnesses around the world. One of the most common chronic illnesses that is spreading among young and old people is diabetes mellitus. It is considered the disease of the 21st century [Engelgau *et al.* 2003].

Diabetes is a metabolic disorder that results from different conditions [Zimmet *et al.* 2001]. It is characterised by chronic hyperglycaemia that is caused by a defect in the pancreas. Either it is not producing insulin, or the body is unable to use the insulin pumped out by the pancreas [American Diabetes Association, 2013]. Furthermore, hyperglycaemia is characterised by a high concentration of glucose in the blood. On the other hand, hypoglycaemia is the dramatic decrease of glucose in the blood [Loader *et al.* 2002].

Diabetes has two main types; insulin-dependent diabetes mellitus (IDDM), which is known as Type 1 diabetes, and non-insulin-dependent diabetes mellitus (NIDDM), which is known as Type 2 diabetes [Alberti and Zimmet 1998]. Furthermore, it has been found that Type 1 diabetes is caused by an autoimmune destruction of beta cells, causing an absolute deficiency in the production of insulin [Yoon and Jun 2005; American Diabetes Association 2013]. On the other hand, in Type 2 diabetes the deficient insulin action is caused by both an insufficient insulin production and the body's resistance to the insulin produced [American Diabetes Association 2013]. Even though both types have different causes, they have very similar symptoms such as polyuria, polydipsia, weight loss, and blurred vision [Alberti and Zimmet 1998].

Given the numbers of diabetic patients in the world and its high prevalence, it has been called an "epidemic" by some papers [Bassett 2005; Zimmet *et al.* 2001]. In a study carried out by Wild et al. (2004), the prevalence of diabetes for all age groups worldwide was estimated to be 2.8% in 2000 and 4.4% in 2030, resulting in an increase of 195 million patients in the expected total number of people with diabetes by 2030. The study also shows that the prevalence in men is higher than in women. Paradoxically, the number of diabetic women is higher than that of men [Wild et al. 2004].

According to IDF countries with low and middle-income population have more diabetic patients than others[2]. Moreover, China, India and the United States of America are on the top of the list of countries with diabetic patients. The IDF also shows the world's top 10 countries for prevalence of diabetes, and six of those countries are in the Middle East. The statistic shows that Saudi Arabia is the 7th country on the list in 2011 and it is estimated to be the 6th by 2030. Neighbouring countries such as Kuwait, Bahrain, Qatar and the United Arab Emirates are also on the list. This huge number of diabetic patients in the world is mainly due to Type 2 diabetes. Moreover, the IDF statistics show that the prevalence of Type 2 diabetes is the highest in the Middle East. Saudi Arabia is also

[2] http://www.idf.org/diabetesatlas/5e/the-global-burden

thought to be one of the largest contributors to the total number of children with Type 1 diabetes. These children are estimated to account for almost a quarter of the region's total of 65200 children with type 1 diabetes. Therefore, it is essential to understand the magnitude of the problem and take the necessary steps to control it.

This explosion in the number of diabetic patients in the Middle East and the world is believed to be a result of population growth, urbanisation, socioeconomic developments and changes in lifestyle [Wild et al. 2004]. An inactive lifestyle, higher life expectancy and the prevalence of obesity due to unhealthy diets are also factors that affect the number of diabetic patients.

Nevertheless, diabetes is a very serious illness that requires time and effort to maintain a good and healthy life. If it is left untreated it could lead to death or at the very least cause damage to many organs in the body, especially eyes, kidney, nerves, heart and blood vessels [American Diabetes Association 2013]. Uncontrolled diabetes also leads to serious consequences such as nonketotic hyperosmolar syndrome [American Diabetes Association 2013]. Thus, monitoring diabetes is crucial to prevent these complications. However, it is not an easy task. Although in some situations patients can control their diabetes by exercising and adopting a healthier lifestyle, other patients require very close supervision and insulin to survive [American Diabetes Association 2013]. They also have to keep track of their blood glucose and watch their diet to maintain the average blood glucose level.

2.1.1 Health 2.0:

The technologies in Web 2.0 expanded the web by creating online communities that collaborate and share data [Ankolekar *et al.* 2007]. This dynamic nature emphasised self-publication and the collaborative creation of web content. Furthermore, Web 2.0 succeeded in turning web content users into content producers [O'reilly 2007]. As a result, this advancement in Web 2.0 technologies and approaches led to significant development in eHealth [Eysenbach 2008]. Thus, a growing number of support groups and self-management tools are swarming the internet [Hughes *et al.* 2008; Van De Belt *et al.* 2010].

2.1.1.1 Social networks:

The development of internet technologies allows medical education programs and support groups to move from the traditional face-to-face settings to an online one [White 2001]. Today, a lot of disease-specific social networking sites exist [Greene *et al*. 2011]. Online social networks and online groups are web-based services that allow users to create profile accounts and share thoughts with other users who share their interests [Boyd and Ellison 2007]. They provide a sense of community, which is what most people are looking for [Madara 1997]. In addition to providing an emotional and psychological support for patients, these communities are becoming a source of knowledge to those patients [Zrebiec 2005]. They are particularly important to patients living with chronic illnesses such as diabetes, which can be a lonely illness [Sentenac and Paule de Viguier 2013]. Being part of those communities makes diabetic patients feel less isolated and more knowledgeable about their illness and self-care [van der Ven 2003; Zrebiec 2005].

The traditional face-to-face medical education programs and support groups have been shown to have positive influences on patients with chronic illnesses, including diabetes [Davison *et al.* 2000; Clark *et al*. 1992]. However, access to those traditional programs is

not available to everyone. Fortunately, the presence of a large number of online social networks allows users to join them from anywhere and at any time.

Some studies have shown that people with chronic illnesses are more inclined to seek information and support online than others who don't have chronic illnesses [Zrebiec 2005]. These online social networks have many advantages over the traditional approach. For instance, patients from all walks of life can be part of the social network without any obstacles. These online networks are also available for users at all times. Thus, they can take their time in forming responses and asking questions without pressure [White 2001]. Additionally, one of the most important benefits of social networks either online or offline, is their positive effect on mental health [Seeman 1996]. This is particularly important for diabetic patients as they are more inclined to get comorbid depression [Egede *et al.* 2002].

Furthermore, some researchers found that social support groups are the most used feature of diabetes management [Zrebiec 2005]. Greene *et al.* evaluated 15 of the largest diabetes management groups on Facebook. The study involved 480 users and 690 comments [Greene *et al.* 2011]. 66% of the posts related to users' personal experiences with diabetes management. Moreover, 29% provided emotional and psychological support to others. On the other hand, a minority of users were posting some kind of promotional advertisements. Luckily though, the inaccurate clinical recommendations were infrequent.

For diabetic patients these online social groups and communities create a space for sharing personal experiences and exchanging knowledge. Some studies showed that 46% of those who use online communities for diabetes are having positive feelings about diabetes after joining the communities [Zrebiec 2005]. They also show that a large percentage of people are looking for information about diet appropriate for their situation. Moreover, they found that 28% of users were benefiting from these communities in terms of monitoring blood sugar, 28% on their insulin medication and 25% on coping with any complications. Online social networks positively influence the health and well-being of diabetic patients [Barrera *et al*. 2002]. Furthermore, being part of a diabetic community makes some patients hopeful, knowing that they are not in this alone [Zrebiec 2005].

The majority of people joining diabetic communities are interested in monitoring blood sugars and receiving and psychological support. Along with the social networking communities on the web, there are many self-management tools as well. Studies show that these tools assist patients and help them to change their behaviour and health status positively [Lorig *et al.* 2010].

2.1.1.2 Management tools:

Self-management of diabetes is crucial. Patients are recommended to document their blood glucose results and physical activities and share them with their health providers [Heisler *et al.* 2002]. Furthermore, it has been proven that the share of self-monitoring blood glucose data and receiving feedback from health care providers can help in achieving glycaemic goals, such as a reduction in the glaciated haemoglobin [Rao *et al.* 2010]. Indeed, with the use of electronic management services this is made easier. Furthermore, today there is a wealth of apps that can aid people with diabetes in keeping a record of their daily activities. The features of these apps such as the ability to record, analyse, share and obtain feedback, might have a positive impact on patients

[Rao *et al.* 2010]. These tools can also help users to notice any alarming behaviour and view their progress easily. [Table 2-1] shows a number of management apps and their features.

Furthermore, even though the number of diabetic patients in the Arab world is high and increasing rapidly, Arabic management apps and tools are very rare. Thus, patients who cannot speak a language other than Arabic will not be able to gain the advantages from these management tools.

Table 2-1 Management Tools for Diabetes

App	Features
Glooko Logbook[3]	Saves time and eliminates errors by downloading blood glucose readings from the meter to an iPod/iPhone. Allows the user to record carbohydrate intake, insulin dose, activity level and user's feeling. Allows the user to add before or after meal tags to their entries. Shows blood glucose trends. Allows the user to share their progress by email or fax.
dLife Diabetes Companion[4]	Designed by one of the biggest diabetes websites (dLife). Log glucose levels. Provides the user with recipes and nutrition information. Allows the user to connect with the community of the website (dLife). Provides daily, weekly and monthly graphs of the user's progress. Shows blood glucose trends. Allows the user to share progress through email.
Glucose Buddy[5]	Manually enter glucose levels, carbohydrate intake, insulin dose, and activities. Allows the user to view their data on their online account. Sends push notification to remind the user to check their glucose level. Connects the user to the online forum associated with the website. Allows the user to view their blood glucose trends.
WaveSense Diabetes Manager[6]	Allows users to track their glucose levels, carb intake and insulin doses. Allows the user to view their data with easy to read charts and graphs. Provides the user with videos from dLife website to learn about healthy diet, lifestyle choices, and hear from other diabetic patients.

[3] https://www.glooko.com/
[4] http://www.dlife.com/dlife_media/mobile
[5] http://www.glucosebuddy.com/
[6] https://itunes.apple.com/en/app/wavesense-diabetes-manager/id325292586?mt=8

2.1.2 Gamification:

Gamification is a concept that covers the use of game designs and development mechanics in fields other than games[7]. In other words, it is applying the principles of engagement, reward and incentive to certain tasks [Law *et al.* 2011]; thus, encouraging changes in behaviour or motivating users to learn new skills. The concept of gamification is not new; it exists in many aspects of our lives. For instance, in school children are awarded a gold star for giving a correct answer or being good in class. In work also, employees are awarded the title "employee of the month" for producing high quality work. These rewards give them some sort of status, even if it was for a simple task. Nonetheless, it is an old topic in human-computer interaction. Actually, *'the attempts to derive heuristics for enjoyable interfaces from games reach back to the early 1980s'* [Deterding *et al.* 2011].

Gamification supports changes in behaviour [Deterding *et al.* 2011]. This makes it a powerful tool if used in education and health fields. Moreover, there is a large volume of published studies which prove that intangible rewards give people subjective feelings of liking and pleasure [Schultz 2006]. The Russian physiologist and Nobel Prize winner Ivan Pavlov defined rewards as anything that results in a change in the behaviour [Pavlov 1927]. In his experiment, the dog salivated to the sound of a bell. This happened only after the sound had been paired with a sausage. Furthermore, the dog did not salivate to different sounds that were not paired with food. This suggested that the behavioural response has been altered after food conditioning [Schultz 2006]. In addition, B. F. Skinner, the American psychologist and behaviourist[8], coined the term "operant conditioning"; this means the changes in behavioural that result from reinforcement. In his experiment, he studied the behaviour of a rat in what is known as "Skinner's box" [Skinner 1938]. In the box, there was a lever; when pushed it delivered a cheese pellet. After a while, the rat learned that when the lever was pressed he would get his cheese. Both experiments suggest that a person/animal would repeat more of the same behaviour that has previously led to a rewarding outcome; this is known as positive reinforcement [Schultz 2006; Skinner 1938]. Therefore, when applied in gamification, positive reinforcement can be used in terms of rewarding users for doing a certain task. For instance, users can be rewarded by communicating with others in an online community. This will reinforce the existing positive feelings that come with participating in something and helping others [McLure Wasko and Faraj 2000]. This might also trigger a sense of competition between users, pushing them to be more active in the community.

A variety of techniques are used in gamification. Some of the popular video game techniques utilise achievement badges, levels, leader boards and progress bars [Kapp 2012]. Others also contain virtual currency, systems of awarding, redeeming, trading, gifting and exchanging points. Moreover, most video games have techniques used in apps and websites which create challenges against other players in order to shift users' behaviour. This is a key factor in the popularity of gamification. Furthermore, the challenge, fantasy and curiosity in video games are important [Malone 1981].

Game design and development mechanics are increasingly surpassing their traditional boundaries [Deterding *et al.* 2011]. Following the success of the location-based service Foursquare, gamification has gained much attention [Deterding *et al.* 2011]. According

[7] http://www.gartner.com/newsroom/id/2251015

[8] http://en.wikipedia.org/wiki/B._F._Skinner

to Gartner, the world's leading information technology research and advisory company, more than 20% of the biggest public companies around the world have gamification apps and websites[7]. This number is estimated to rapidly increase over the next few years. Furthermore, it is predicated that by 2014 more than 70% of Global 2000 - the top 2000 public companies in the world - organisations will have at least one gamified application[7]. This huge rise is due to the quick and real results seen by organisations that have already applied gamification in their apps and websites. Gartner's statistics indicate that these organisations have experienced an increase of 29% in site actions in a short period of time. This indicates the power of gamification.

2.1.3 Gamification in Healthcare:

Gamification can be used in health care applications and websites to encourage behavioural change. Professor Kevin Werbach, the author of '*For the Win: How Game Thinking Can Revolutionize Your Business*', argues that gamification is fundamentally a motivational tool [Werbach 2012; Doyle 2013], increasing users commitment to certain health behaviours, or encouraging users to exercise more and take medication regularly. Furthermore, an increasing number of apps are dedicated to gamifying healthcare. Gamification expert, public speaker, entrepreneur and author of '*The Gamification Revolution'* Gabe Zichermann, is among others who argue that using the concept of gamification in healthcare websites and apps is a natural fit [Zichermann 2012; McCallum 2012]. For instance, rewarding systems could be used to encourage healthier choices.

Referring back to Skinner's work, the reinforcement explained in his experiment could be seen as either positive or negative [Skinner 1938]. Both reinforcements resulted in a desired change in behaviour. However, when implementing gamification techniques in the healthcare arena, it is worth noting that using positive reinforcement is more effective than negative. Rewarding a patient for taking their medication is more likely to encourage them to keep doing so more than taking away points if they did not take their medication regularly. Furthermore, gamification can play a very important role in changing the negative connotation behind making healthier choices. That is the notion that making the right decision today is a sacrifice for a better tomorrow. On the contrary, gamification could make exercising and making healthier choices fun to do [King *et al.* 2013].

However, not all gamified apps are using positive reinforcement. For example, Stickk, which is designed to help users commit to a goal, such as quite smoking requires the user to enter their credit card information and pay every time they smoke[9]. Thus, users end up cheating. Some argue that this is the reason behind the failure of the app [Doyle 2013]. However, the concept of gamification, if used correctly, can motivate people to make better decisions concerning their health. A successful example is the mobile app SuperBetter, which is a tool for self-improvement[10]. It helps the user to achieve a number of goals ranging from injury recovery to diet. Basically, it keeps track of the user's "quests" and presents the daily and weekly to-do lists to reach the goal one step at a time.

Gamification has also been used in diabetes management. MySugr[7] is one of the apps for managing diabetes. It helps users to track their blood glucose levels along with other

[9] http://www.techhive.com/article/259717/
[10] https://www.superbetter.com/about

relevant data such as their carbohydrate intake and medication. The app also allows users to keep a photo diary of their meals. Furthermore, it rewards users who are committed to logging their information. One of the gamification features in the app is a representation of diabetes as a monster that the user must tame. Such features are important to capture the attention of the user. In fact, it has been estimated that 80% of gamified apps will fail by 2014 due to poor design[7]. Moreover, a study done on a gamified diabetes app showed an improvement in the patients' monitoring of blood glucose [Cafazzo *et al*. 2012].

Finally, the applications and desktop tools that utilise game designs and techniques to tackle diabetes are still limited in number. Most of what is already done is in English. Currently, the Arab world lacks any kind of gamified diabetes app or tool.

2.2 Summary

The aim of this dissertation is to present a web-based system that targets diabetic patients in Saudi and the Arab world. This web-based system will use game techniques and act both as a social network and a diabetes-managing tool. As proven in different studies, the need for a support group is essential to patients with diabetes. They are also required to closely manage their diabetes. Moreover, there are many tools to assist them in doing so. However, committing to such tools is tedious. Fortunately, the use of gamification in apps and websites has succeeded in capturing the users' attention. Game techniques also help in changing the behaviour of users. Thus, the website presented in this dissertation will engage these techniques to change users' behaviour and reinforce positive behaviours. Lastly, by creating this community of Arab diabetic patients the website will help in enriching the Arabic online content regarding diabetes.

Chapter 3. Analysis and Requirements

In this chapter a feasibility study was created to evaluate the likelihood of the project's success. Furthermore, the idea was analysed and requirement statements were constructed.

3.1 Feasibility Study:

A Feasibility study is carried out in order to examine the likelihood of the project success before the actual start of a project. It shows the advantages and disadvantages of the project. Furthermore, it helps in deciding whether the project is the best solution for the problem or not. The acronym TELOS[11] is used to assess the different dimensions of feasibility.

Table 3-1: TELOS

Technological
Q: Can the developer build it and are the needed technologies available?
A: The technologies needed to complete this project are available for the developer to install. The developer acquires the needed knowledge to develop a web-based system.
Economical
Q: Is the project worth the investment?
A: The project is done for an MSc dissertation. It is self-funded by the developer. The budget will be divided between the domain name and the hosting service.
Legal
Q: Are there any legal responsibilities?
A: The information published on the website should be accurate and cited.
Operational
Q: Is it likely that the system will solve the problem or fill the existing gap?
A: This solution aims to gamify and reinforce positive behaviour in managing and dealing with diabetes in the Saudi Arabia and the Arab world. Naturally, people resist change, so this must be taken into consideration when launching this project. Cultural issues should also be taken into consideration in the development.
Schedule
Q: Is it likely to be built in the assigned time?
A: The timeframe for this project is limited. However, the project can be completed on time with realistic goals and following the detailed plan.

3.2 Requirements

Requirement statements for the system were formulated after a careful study of existing solutions and defining the goals and objectives for the recommended solution. Writing and verifying a complete set of requirements is key to the production of a successful system [Fellows 2003; Boehm 1984]. In this section, both functional and non-functional requirements are presented. The functional requirements are the basic functions

[11] http://en.wikipedia.org/wiki/Feasibility_study

expected of the system. On the other hand, non-functional requirements are about performance, security and reliability. The statements were written with the requirements standards in mind to avoid any ambiguity. Every requirement statement is coupled with a rationale statement to explain it in more detail [Fellows 2003].

3.2.1 Functional Requirements

The functional requirements describe the desired functionality of the system. It consists of high-level statements that outline the behaviour of the system. Each requirement listed in [Table 3-2] is arranged in a scale from low to high where "high" indicates its importance to the system. It also includes a rationale to explain each requirement.

Table 3-2: Funcational Requirements

	Requirement/Rationale	**Priority**
F.R.1	The system shall provide profile accounts for each user.	HIGH
Rationale	Each user must have his/her own account to be able to keep a log of his/her glucose levels, share progress, and communicate with other users.	
F.R.2	The system shall enable the user to keep a logbook of blood glucose level tests and information associated with it.	HIGH
Rationale	Each user should be able to keep a logbook of his/her blood glucose levels and related information to help manage their diabetes and recognise any patterns.	
F.R.3	The system shall allow users to interact with each other and send messages.	HIGH
Rationale	A social network should be created to enable users to interact with one another. This will act as a support group, which proves helpful with diabetic patients. They will be able to share advice, experiences etc.	
F.R.4	The system shall reward users based on several aspects such as committing to logging test values.	HIGH
Rationale	Users who log their test readings continuously should be rewarded for that. As their points accumulate they will receive advantages over those who did not log continuously. This will encourage users to keep logging.	
F.R.5	The system shall provide the user with a graph of his/her blood glucose information for each month.	HIGH
Rationale	Users need to view their progress every month. A graph is an easy way to allow them to do so.	

3.2.2 Non-functional requirements

Non-functional requirements can be defined as statements that describe the behaviour of the system instead of what it does [Chung *et al.* 2000]. These include performance requirements, external interface requirements, design constraints and quality attributes. Furthermore, non-functional requirements describe the qualities that the system must have to be a successful product[12]. They place restrictions on the system and process and specify external constraints that the product must meet. As with the functional requirements above, [Table 3-3] lists the non-functional requirements and specifies their

[12]http://searchsoftwarequality.techtarget.com/answer/Functional-and-nonfunctional-requirements

priority from low to high, where high means it is fundamental to the success of the system and must be fulfilled.

Table 3-3: Non-Functional Requirements

	Requirement/Rationale	**Priority**
N.F.R.1	The system shall target Arab diabetic patients; specifically, Saudi patients.	HIGH
Rationale	The system will be written in Arabic targeting Saudi patients and other Arab patients because of the lack of similar websites/apps in Arabic.	
N.F.R.2	The system shall be simple to use and user friendly.	HIGH
Rationale	Users should be able to use the system without any complications.	
N.F.R.3	The system's purpose shall be clear to all users.	HIGH
Rationale	The homepage should explain the purpose of the website in a clear way.	
N.F.R.4	The system shall adopt a credible diabetes control chart.	HIGH
Rationale	It is very important to build the system using the right information about diabetes control, such as acceptable glucose levels.	
N.F.R.5	The system shall provide a sufficient bandwidth to cater for the number of users	HIGH
Rationale	This is necessary in order to serve a large number of users and give quality service; this will also maximize the uptime of the system.	
N.F.R.6	The system shall apply the guidelines of HCI and provide a clear and attractive layout with appropriate colour scheme.	HIGH
Rationale	Users should be able to identify content easily and should find the system pleasant to use.	
N.F.R.7	The system shall apply the accessibility and usability guidelines to cater for all people.	MODERATE
Rationale	All users should be treated equally.	
N.F.R.8	The system shall secure passwords and data.	HIGH
Rationale	Users' data should be secure and protected against any misuse.	
N.F.R.9	The system shall have a simple backup facility.	HIGH
Rationale	Backup facility should be used to prevent the loss of data and ensure its restoration if it problems occur.	
N.F.R.10	The system shall provide a table with all the badges and levels and explanations of how to get them.	HIGH
Rationale	Users should be able to view the badges and the points needed to acquire them.	

3.2.3 Constraints

Constraints are statements that shape the scope of the project. Here we defined three constraint statements for the system:

- The timeframe for this project is limited to three-months.

- The frameworks environment is new and the developer is not familiar with it.
- The regulations and standards of the medical field need to be applied.

3.3 Risk Analysis:

All projects have risk factors associated with them. However, it is necessary to carry out a risk analysis in the early days of the project to prevent or minimise negative events that could impact the success of the project. As Scoy explained: *'... we must learn to balance the possible negative consequences of risk against the potential benefits of its associated opportunity'* [Scoy 1992].

The SEI risk management paradigm is adopted in this project [Figure 3-1]. The elements of the risk management paradigm are: Identify, analyse, plan, track, control, and communicate [Table 3-4].

Table 3-4: The Elements of risk management paradigm [Williams *et al.* 1999]

Element	Purpose
Identify	Identify all known project risks.
Analyse	Analyse the available risk data.
Plan	Create mitigating plans based on the risk information.
Track	Monitor risk indicators and mitigation actions.
Control	Prevent any deviations from the risk mitigation plans.
Communicate	Enables the sharing of information throughout the project.

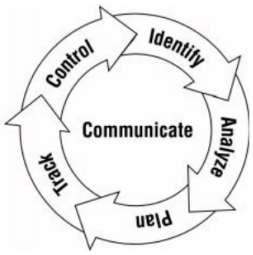

Figure 3-1: SEI Risk Management Paradigm [Williams *et al.* 1999]

Following the risk management paradigm, the first step is to identify any possible risk. Then, the possible risk should be analysed while taking into consideration the probability of its occurrence and its impact on the success of the project. After that, a plan must be made to avoid it. Finally, the project must be continuously monitored to prevent any deviations from the mitigation plans.

3.3.1 Risk Assessment:

In this section a risk assessment table is provided. Risk assessment can be defined as a way to measure both the qualitative and quantitative value of the risk associated with the project. This is done to identify any threats to the project's successful implementation. To calculate a rating for each risk the following formula was used:

Rating = Severity of the threat X Occurrence Probability

A scale of 1-5 (1 being very low and 5 being very high) was used to rate both the severity of the threat and its probability of occurrence. The full risk assessment of this project identified two Low, four Moderate and three High risk factors [Table 3-5].

The risk assessment indicates that the timeframe must be respected in order to meet the deadline with a completed project. Thus, activities should be prioritised and a contingency plan should be available. Furthermore, testing must take place during the implementation phase and before the launch of the website to identify and fix errors. Lastly, the project should be developed with the user in mind.

Table 3-5: Risk Assessment
Key: P. R. = Possible risks, S= Severity, O. P. = Occurrence Probability, R= Rating,

P. R.	Indicators	S	O. P.	Mitigation	Solution	R
Hardware Failure	Malfunction within the hardware preventing it from working properly.	3	2	Make sure hardware is working as intended before the start of the project.	Use other hardware or replace the faulty element.	6
Data Loss	The loss of data due to SW/HW failure.	3	3	Back up data regularly to a secure storage facility.	Prioritise data and recreate them according to time.	9
Software Failure/Corruption	Malfunctions in the SW preventing it from working properly.	2	3	Make sure software works before the start of the project.	Replace the faulty software or contact developer for solution.	6
Requirement Changes/Edits	Changes/edits in requirements revealed in later phases of the project.	4	2	Ensure that the requirements are fully understood from the beginning of the project.	Add the new requirements to the document while making sure it is coherent and clear.	8
System Errors	The system fails to work as intended.	5	4	Complete the testing phase before launching.	Identify errors continuously and fix them.	20
Underestimation of System Complexity	Finding the system hard to complete.	4	3	Plan according to the developer's abilities.	Look for help from books or experts.	12
Lack of Time	Inability to complete project within the timeframe.	5	3	Plan ahead with the developer's ability and timeframe in mind.	Prioritise activities and create a contingency plan.	15
Slow Progress	Slow progress due to lack of productivity.	4	2	Plan efficiently in order not to overwhelm the developer.	Take breaks regularly and focus on the end result.	8
Few Users	Users are not interested in the website.	5	3	Design with the user in mind and market the project properly.	Evaluate the existing solutions and users' needs.	19

3.4 Cost-Benefit Analysis:

A cost-benefit analysis is used to estimate the value of the project. It evaluates the costs and benefits associated with designing and implementing the website. It helps in making a rational decision of whether to continue with the project or not.

3.4.1 Costs

The costs associated with the project were calculated [Table 3-6]. Some of the costs recur annually, but others occur only in the first year.

Table 3-6: Costs associated with the Development

Component	Year 0	Year 1	Year 2	Year 3	Year 4
Web server*	£999	-	-	-	-
BT Line + Broadband connection	£360	£360	£360	£360	£360
Domain Hosting	£53.81	£53.81	£53.81	£53.81	£53.81
Domain Name	£ 2.99	£ 2.99	£ 2.99	£ 2.99	£ 2.99
System Development @ £20/hr (720 hrs)	£14400	-	-	-	-
Total	£15815.8	£416.8	£416.8	£416.8	£416.8
Grand Total					£17066.2

* MacBook Pro, Processor: 2.4 GHz Intel Core 2 Duo, Memory: 4 GB 1067 MHz DDR3

3.4.2 Benefits:

The website does not charge users for registration and usage. However, profit can be generated through advertising. Furthermore, the profit generated from advertising can be used to maintain the website. In order to calculate the benefits, the numbers of users, visits and clicks were estimated. The calculation was made based on the number of internet users and diabetic patients in Saudi Arabia [Table 3-7].

According to the cost calculations, the total cost of the system is £17066.2 in five years [Table 3-6], while the total revenue is £331170 [Table 3-7]. To calculate the net income in five years, the grand total cost is subtracted form the grand total revenue. Using the formula "total revenue – total cost" the net income would be £314104 in five years. Moreover, the system would return the initial investment of "£15815" on the first year and return revenue of £5401. This concludes that the system is a valuable investment.

Table 3-7: Associated benefits of the website

Component	Year 0	Year 1	Year 2	Year 3	Year 4
Potential no. Of users (1% of diabetic internet users, and annual increase of 5%)	10608	11384	11695	12280	12894
Average no. Visits (100 /user)	1060800	1138400	1169500	1228000	1289400
Estimated Clicks (10% of total visits)	106080	113840	116950	122800	128940
Cost Per click (CPC)	£0.20	£0.30	£0.40	£0.50	£0.65
Total	£21216	£34152	£46780	£61400	£83811
Grand Total					£331170

3.5 Use Case Diagrams

UML use cases were created to describe the functionality of the system. Use cases show what the system can do but do not represent the order or number of times that the systems actions and sub-actions should be executed. They contain four major elements: actors, system, use cases and the relationships between them. Based on the functional requirements of the system, a number of use cases were created [Figure 3-2].

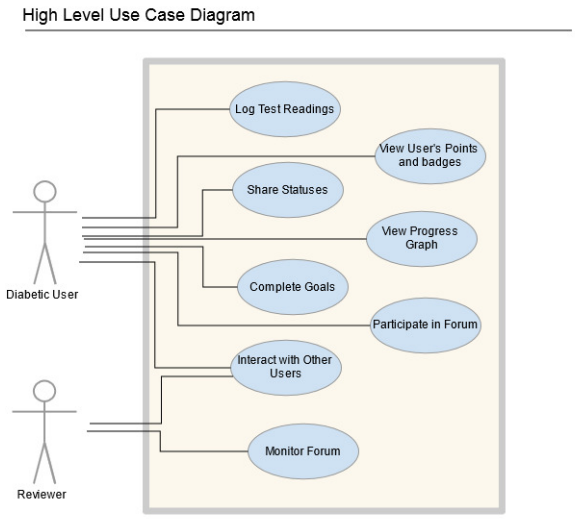

Figure 3-2: High level Use Case Diagram

3.6 Personas and Scenarios

Personas and scenarios are fictional characters and stories used to aid the design of a system [Sears and Jacko 2009]. They emphasise the user's needs and wants from the system. This technique helps in staying connected to the user and the real world while designing the system[13]. Thus, they enable the designers to build a web-based system that is usable and user-centric. Three personas were created for this website. Each character has his/her own scenarios that provide insight on what they need from the website [Table 3-8].

Table 3-8: Personas and Scenarios

Character	Details
	X is a 20-year-old student in his last year of university. He was diagnosed with diabetes type 1 at the age of 7. Even though he has had diabetes for a long time he still struggles to meet his glucose level goal. Therefore, he started using logbook apps and websites to spot any patterns. However, he could not commit to logging his readings every time. Furthermore, he wants to meet other diabetic patients his age, as they would understand what it means to be diabetic and share with him experiences regarding diet, sport and the everyday life of a diabetic patient.
	Y is a 13-year-old girl who was diagnosed with diabetes type 1 at the age of 10. She does not have any friends with diabetes and is very insecure about her condition. She refuses to follow the rules

[13] http://graphics.cs.columbia.edu/courses/csw4170/useScenariosAndPersonas.htm

	and diet her doctor recommended and wants to be like her friends. Her parents want her to meet other diabetic patients to help her understand that she is not alone.
	Z is a 25-year-old diabetic patient. He was been diagnosed with diabetes type 2 four years ago. He struggles with keeping a log of his blood glucose readings. He does not speak English and could not find diabetic management applications and website tools in Arabic that cover his needs.

Chapter 4. Design Phase:

In the design phase, a plan for the rest of the project is built[14]. It will provide an outline of the entire system and identify the key elements on an abstraction level[15].

4.1 Navigation structure

One of the key elements to planning a website is having a good navigation structure[16]. Building a navigation structure requires a high level view of the main functions of the website. [Figure 4-1] shows the topography of the system and its content as well as the user privileges.

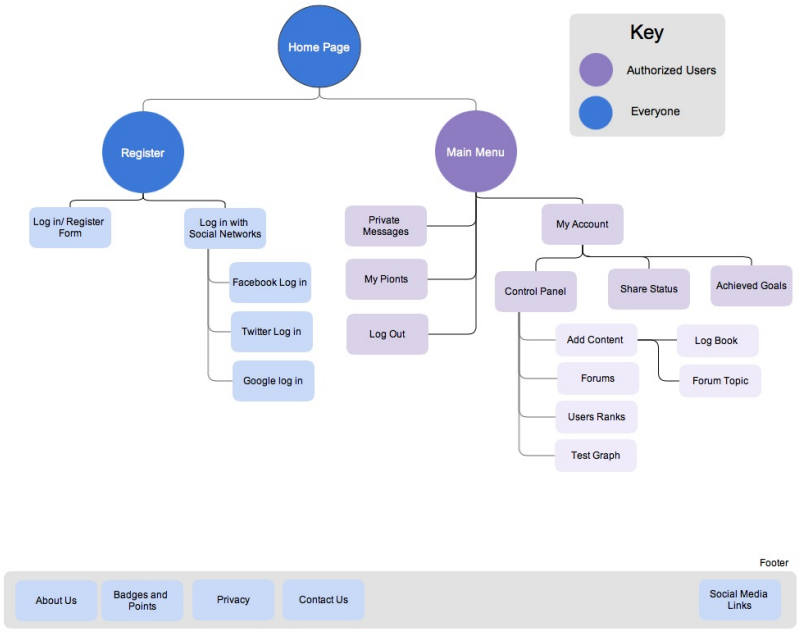

Figure 4-1: Website Navigation Structure

4.2 Logo Design:

A logo might seem like a trivial thing. However, the psychology behind a good logo design is very effective. It is the meaning associated with the logo other than the meaning of identification[17].

In the logo design, any attribute that allows the creation of an additional meaning can be used to create a meaning[18]. In the design of our logo this was taken into consideration [Figure 4-2]. The logo is designed with both Arabic and English words. The word "Sukr", which means both sugar and diabetes in Arabic, was added from the URL to the logo. It

[14] http://msdn.microsoft.com/en-us/library/windows/desktop/cc307414.aspx

[15] http://en.wikipedia.org/wiki/High-level_design

[16] http://www.dummies.com/how-to/content/how-to-develop-a-navigation-structure.html

[17] http://www.hongkiat.com/blog/symbols-impact-on-logo-design/

[18] http://www.webdesignerdepot.com/2012/08/the-psychology-of-logo-design/

was written in both Arabic and English to link the two and make it more memorable for the user.

Furthermore, the use of vowel marks from Arabic diacritics is to customise the logo to the Arabic culture. Moreover, the "Sukun" mark [Figure 4-3], which resembles the diabetes logo [Figure 4-4], is a focal point in the design. The size of the "sukun" is intentionally bigger to draw the attention towards it.

Finally, the colours of the logo were chosen carefully. Both the grey and the light blue colours are the colours of the international diabetes logo and awareness ribbon[19].

Figure 4-2: The logo

Figure 4-3: Sukun [20]

Figure 4-4: International Diabetes Logo[21]

4.3 Activity Diagram

Activity diagrams are techniques that help in describing the procedural logic and work flow of the system [Canevet *et al.* 2004]. Two activity diagrams were created to illustrate two features of the system. [Figure 4-5] is an activity diagram for the logging of a test reading, and [Figure 4-6] is for the user login to the system.

[19] http://en.wikipedia.org/wiki/List_of_awareness_ribbons
[20] http://www.charbase.com/0652-unicode-arabic-sukun
[21] http://www.diabetesbluecircle.org/

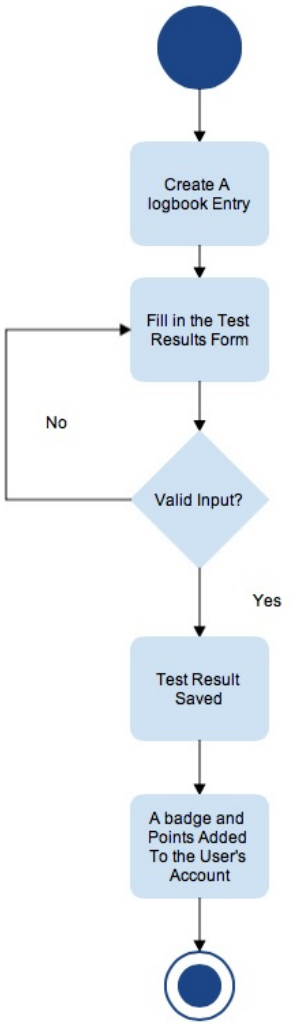

Figure 4-5: Activity Diagram for Logging a Test Reading

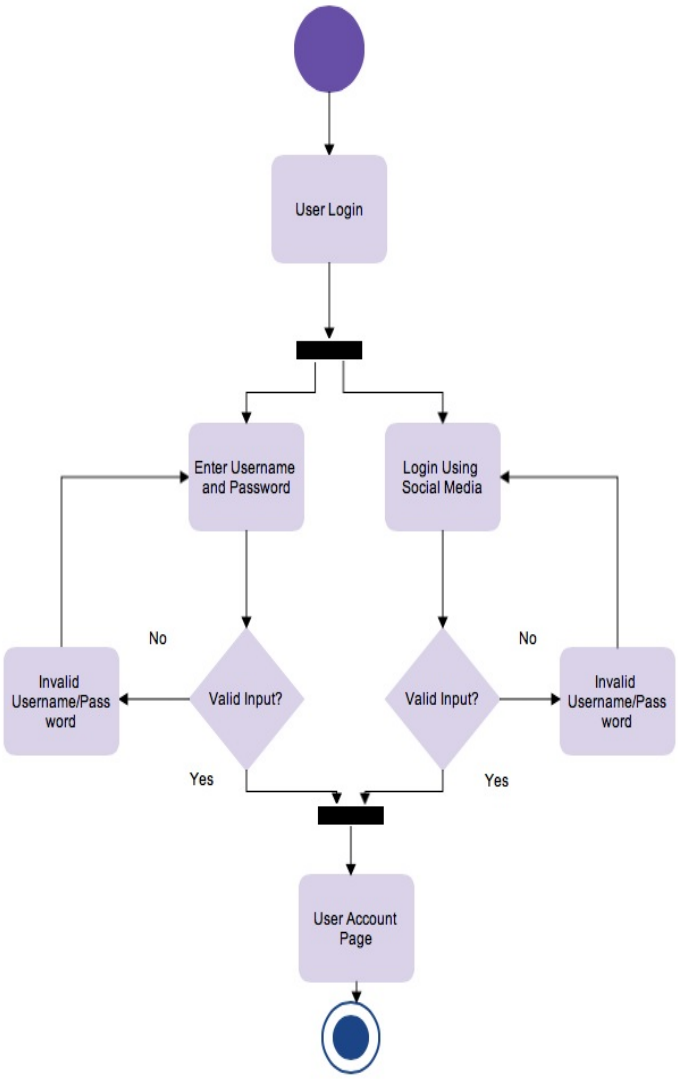

Figure 4-6 Activity Diagram For Login

4.4 Sequence Diagram

Sequence diagrams show in detail the interaction between actors, system and system components [Fowler 2005]. Two sequence diagrams were created to display the interaction between the user and the system when logging into the system [Figure 4-8] and logging test details [Figure 4-7].

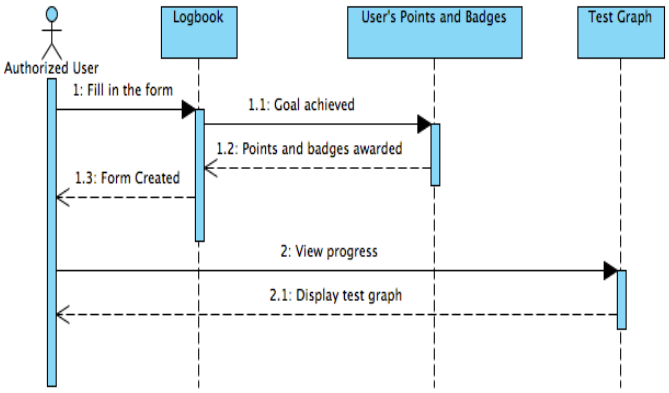

Figure 4-7: Sequence Diagram for Logging a Test Result

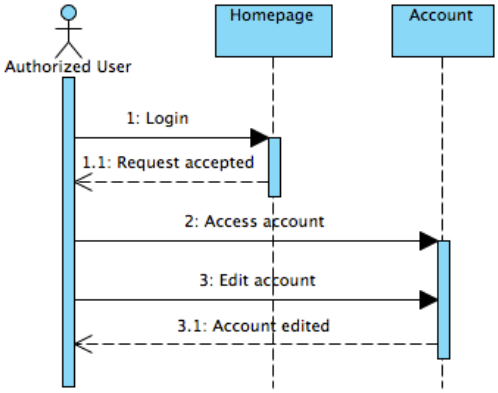

Figure 4-8: Sequence Diagram for User Login

4.5 User Interface Design

The look and feel of any system is very important [Marcus and Gould 2000]. The goal of the design is to make the user's interaction with the website simple and clear. A number of interfaces were designed using Mockingbird[22], which is an online tool to create mockups for the system's interface. [Figure 4-9] shows the home page, which can be viewed by all users, whether they are registered or not. It is divided into three parts. Each part has a title and an explanation of the main ideas of the system; manage diabetes, communicate with other diabetic users, achieve goals and score points. On the other hand, [Figure 4-10] shows the user's account page and the logbook. There will be a control panel on the right side of the page, because the website will be in Arabic. Furthermore, the page will show the user's achieved goals and badges. Finally, [Figure 4-11] shows the test graph that provides a visual representation of the test results entered by the user.

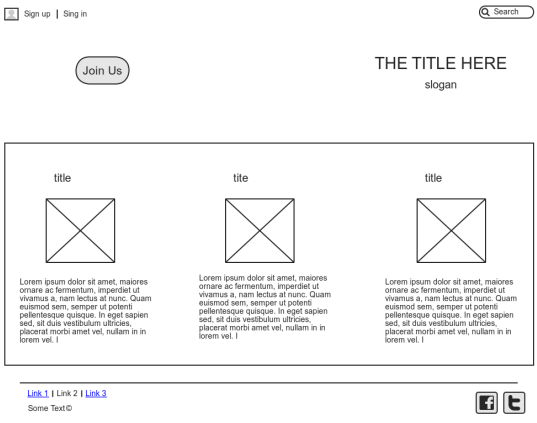

Figure 4-9: Home Page User Interface Design

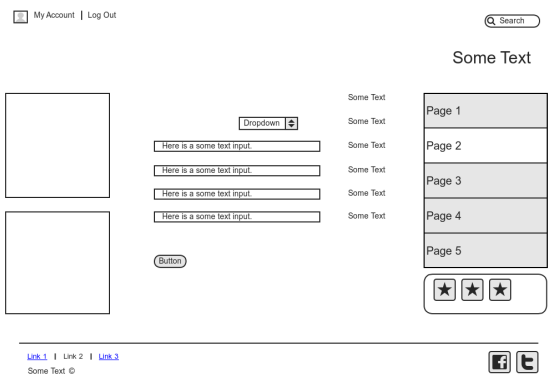

Figure 4-10: User's Page Interface Design

[22] https://gomockingbird.com/mockingbird/

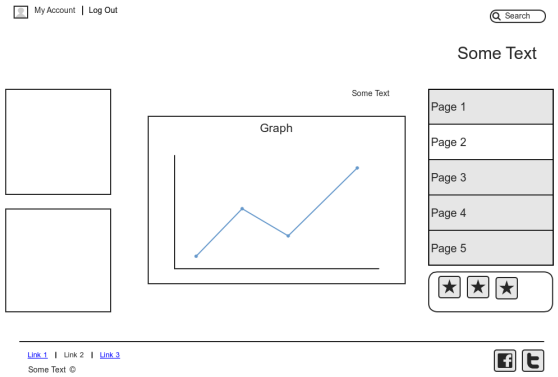

Figure 4-11: The Test Graph Page

4.6 Gamification design:

Gamification is the use of game mechanics and methods in a non-gaming environment [Sumner 2011]. Game mechanics are rules and guidelines developed by game designers to produce a game or a gamified system [Lundgren and Bjork 2003]. These rules and theories differ depending on the purpose of the game. For the purpose of this system the focus will be on points, which are at the heart of any game [Zichermann and Cunningham 2011]. These points are represented in badges and leaderboards. Users would have a list of goals to complete and for each achievement they would be rewarded with points and badges [Table 4-1]. This list of goals will inevitably expand and grow with the system and based on the user's behaviour.

Table 4-1 Goals

Badge	Points	Goal
	10	Getting Started and registering in the system.
	20	Logging a test result.
	30	Logging a test reading 3 times a day.
	15	Posting on the forum.
	30	Active in the forum; posting 10 times within a week.
	50	Logging test readings 3 times a day consistently for a week.

In a video game the score is always on the screen letting the user know where they stand in relation to the next level. In this system the points should be apparent to all users. A list of users and their points would trigger competition between them. The system has two types of points; experience points and karma points [Table 4-2].

Furthermore, in a gamified system, players are not usually competing for the prize; instead, they are looking for status, and this status is considered a reward [Zichermann and Cunningham 2011]. In order to design the gamified system the acronym SAPS was examined [Zichermann and Cunningham 2011]. It stands for status, access, power and stuff. Furthermore, it lists the potential rewards in order from the most desired to the least [Table 4-3].

Table 4-2: Types of Points

Experience points:
When users complete a list of goals they and get rewarded by points. Thus, the more they use system the more points they have.
Reason:
To get users addicted to the website and reinforce positive behaviour. Specifically, to let users log their tests more. Thus, they will be able to view their graph and visualise their progress. The system aims to let users spot patterns and eventually act according to them.
Karma points:
Where users get to give points to other users. For instance, if a user shared an interesting post on the forum, other users can award him/her points if they like it.
Reason:
This will encourage users to post on the forum and be active in the community. As research shows, being involved in a community help diabetic users tremendously.

Table 4-3: SAPS [Zichermann and Cunningham 2011]

Status:
A status is the position of an individual in comparison to others in a social group. In a gamified system, this gives players the ability to utilise status benefits and rewards, giving players the ability to move ahead of other users in a defined ranking system.
Access:
Provide users with special access based on their behaviour in the game. Users who score high points have special treatment compared to those who have lower scores. The Points could also unlock a lot of the system's features.
Power:
Giving power and control to users over others. Users could be offered positions on the website - such as the ability to start groups or arrange meetings – which they would not otherwise be able to do.
Stuff:
Giving people freebies and prizes.

Because of the time limit in this project, the focus would be on giving users status instead of access, power or stuff. To apply this, the badges and level and leaderboards were designed for the system. Badges are known status items, and they are given virtually. One of the most important aspects of the game here is to allow users to view the badges of other users [Figure 4-12]. Otherwise, the value of the badges is limited. Competition for status in this social group should be the drive to change users' behaviour as well as a positive reinforcement power. Furthermore, providing levels and leaderboards is a way to engage users in the website. It aims to encourage them to participate more and be active in logging their tests to achieve a better ranking on the boards [Figure 4-13]

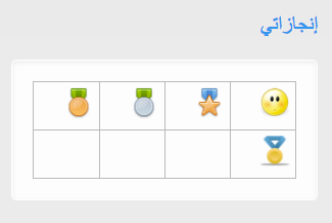

Figure 4-12: Achieved Goals

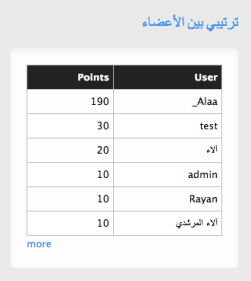

Figure 4-13: Users Points and Ranking

4.6.1 Motivation:

Understanding what motivates users to play or engage in the gamified system is crucial to the success of the system [Zichermann and Cunningham 2011]. There are many reasons why people are motivated to play games. These motivators could be separated into four reasons: for mastery, to de-stress, to have fun, and/or to socialise [Zichermann and Cunningham 2011]. People play games for different reasons and enjoy different kinds of fun. Nicole Lazzaro, an expert on player experience and emotions, divided fun into four categories: hard fun, easy fun, altered-state fun and social fun [Table 4-4] [Lazzaro 2004].

In this project, the focus should be on social fun. People enjoy playing a multiplayer game. According to the study done by [Lazzaro 2004], *'it is the people that are addictive not the game'*. In the proposed web-based system users are encouraged to make friendships and to be part of a community. Adding the social game aspect would attract users to join and compete.

Table 4-4: Types of Fun [Lazzaro 2004]

Hard Fun:
Where players enjoy challenges and winning competitions
Easy Fun:
Where players play the game for sheer enjoyment and exploring it.
Altered-State Fun:
Where players focus on how the game makes them feel.
Social Fun:
Where players enjoy engaging with other players and competing with them.

4.6.2 Flow

Another important factor of the game's success is the flow. It will ensure that the player does not lose interest in the gaming aspect of the system. Furthermore, applying this game technique to our gamified system will be challenging at first. This could be determined after testing the system and examining the feedback and behaviour of users. However, there should be some sort of flow from the beginning of the project.

Chapter 5. Implementation Phase:

During the implementation phase the system is constructed based on the outcome of previous phases. The aim of this phase is to produce a system that meets the requirements of its users. Appropriate measures were taken to implement the principles of accessibility and usability.

5.1 Development Environment:

The website was developed in a server running Mac OS. MAMP was used to create a local server environment by installing PHP, MySQL and Apache. This was done to run Drupal, which is a content management system (CMS) and a web application framework chosen for this project. It is PHP and MySQL based and helps in managing web sites and content. One of the key aspects of Drupal is its community. It has over 63000 users and developers that support it[23]. Drupal is the perfect choice for this project for several reasons. First, it is a CMS, which separates the website's design, content and logic; thus, making the development and maintenance of the website easier. Second, Drupal is a modular framework that permits additional features to be plugged into the website in the form of modules. Moreover, there is a huge library of modules that are supported by developers on the Drupal website. Thus, it is very flexible and can adapt easily to the needs of this project.

5.2 User Interface Layout:

The system's look and feel is very important to attract users. The Drupal website offers a wide range of themes for Drupal developers. The theme chosen for this project is "Corporate Clean" which is designed by Zsolt Kacso[24]. This theme has a responsive layout, which means that users can view the system using any device (notebook, cell phones, tablets etc.) and the pages of the system will resize to fit the browser[25]. This is important to cater to as many diabetic patients in Saudi and the Arab world as possible. Moreover, Saudi Arabia and its neighbouring country UAE have the highest rates of people using smartphones to surf the web in the Middle East[26]. Therefore, making the web-based system works equally well across different devices is important.

The theme has a simple and clean layout with colours that suit this project. It is also divided into 12 regions: navigation, search box, highlight area, content, first sidebar, banner, three footers and a help section. This is good for creating the user account page and the panels.

5.3 Features of the system:

Below are the most important features of the system.

5.3.1 Managing Diabetes:

One of the main features of the web-based system is that it acts as a management tool for diabetes. In order to do that, three functionalities were implemented: logbook for tests, graph to show the performance, and a customisable profile for users.

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[23] https://drupal.org/about
[24] http://kaolti.com/
[25] http://en.wikipedia.org/wiki/Responsive_web_design
[26] http://www.wamda.com/2013/03/13-stats-about-internet-usage-in-the-middle-east

Logbook:

This is a logbook that helps diabetic patients in recording their blood glucose test readings. The logbook also stores information other than the blood glucose results [Table 5-1]. All these fields are important for the user to monitor progress and manage his/her condition better. However, the only field that is required to be filled in by the user is the blood glucose level; others are optional.

Table 5-1: Logbook Fields

Field	Type	Widget	Definition
Title	Node module element	No widget is used here	This is a default field that is automatically generated when a new content type is created. Users can save the title of that entry here, such as "Morning test".
Glucose level	Integer	Text field	It saves the user's blood glucose level.
Before testing	List (text)	Check boxes/radio buttons	Users can choose whether they were testing after having a meal, before having a meal or after fasting for 8 hours or more.
Meal	List (text)	Check boxes/radio buttons	The user has to choose the type of the meal he/she is having; whether it is breakfast, lunch, dinner or snack.
Date	Text	Text field	The user can choose the date from a pop up calendar.
Notes	Text	Text field	In case the user wants to save any notes about that test.
Image	Image	Image	The user can upload an image of their meal or snack to keep in the log. The images sizes are predetermined to prevent a waste of bandwidth.
Mental state	List (text)	Check boxes/radio buttons	The user states how he/she is feeling after and/or before the test by choosing one of the feelings from the list

Graph:

A graph is created based on the user's logbook entry to give the user a visual record of their progress. This will allow users to identify trends. Therefore, they could adjust their diet according to the information they get from the chart. Moreover, the visual record would encourage them to keep their chart balanced.

Profile:

The system has two types of profiles, user profiles and doctor profiles. Every user registered on the website has their own profile. They can enter their information and personalise it with pictures and links to other social networks or their website.

On the other hand, doctor profiles are assigned by the administrator to volunteer doctors who agree to monitor the forum and communicate with users. They have permission to edit user's posts on the forum as well as share articles. This was done to ensure that the circulated information is not false and people are not promoting unhealthy habits. As some research indicated, users can share a lot of false information

and promote different products in these communities that might be harmful [Greene *et al.* 2011].

5.3.2 Gamification:

Although gamification was not taught on the course, it is one of the defining features of this project. Game mechanics were used in combination with psychology to create a system that would increase users' engagement and most importantly influence their behaviour.

Based on the design phase output, goals and rewards were implemented in the system, using the plug-in modules Goals, Points and Entity API, and the rules on Drupal. Furthermore, for every goal created a number of points were assigned as well as a badge. The aim of the point system is to engage users and reinforce positive behaviour.

The points and badges are shown on each user's profile page for everyone to see [Figure 4-12]. This will create a reputation or status for the user in the community and encourage others to achieve more goals and reach higher levels. Moreover, people like to know where they stand in relation to other users on the system. Therefore, there is a display of each user's levels of engagement based on the points awarded with each badge [Figure 5-1].

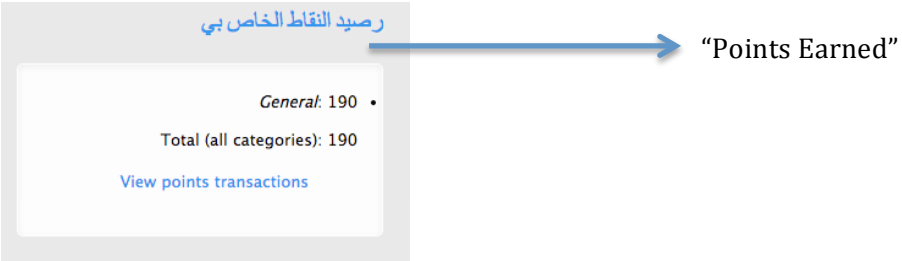

Figure 5-1 Points section on User's Profile

Every goal created is associated with a task or several tasks that would lead to the achievement of the goal. Moreover, the goal itself has points and a goal image, which is a badge in this system. Once the user finishes the tasks of each goal, they get the points and the badge. Furthermore, to prevent users from cheating in the game, constraints are added to every task. These include three main constraints regarding time and the number of times a task can be done. In more detail, there is a limit to the number of times a task can be counted towards the goal per interval. There is also a limit for the timeframe in which task must be completed within.

Now that these goals are created and the tasks are given, they have to be tied with rules using the rules module. This way we can bring the power into play using the rules module. After creating the goals and the tasks, they were tied with rules using the rules module. For every goal, a new rule is created and hooked into the event that leads to the goals achievement. After creating the rule, a condition was added to make sure that it is the right content type.

5.3.3 Other Features:

The system provides a number of features that create a community for users.

Creating a Community:

Creating an online community is one of the fundamental ideas of the system. To do that, three features were implemented on the system. These are; forums, sharing statuses and private messaging. These will enable users to communicate and create bonds and friendships. It aims to allow users who are not able to attend face-to-face meeting for any reason to be part of an online group [White 2001]. It aims to provide patients with a community that they can access and rely on whenever they need to. It also overcomes the socio-demographic factors such as age and gender. This is especially important as it is culturally difficult for both genders to join face-to-face groups and openly share their experiences.

Forums:

Forums are discussion areas on a website where members can discuss topics posted by them and other members. In this project, forums were implemented to allow Arab diabetic patients to post questions about several aspects of their condition in their own language. It will also give them an opportunity to share their experiences and learn from others. Furthermore, this will create a community where Arab diabetic users can get emotional and psychological support as well as share knowledge.
In order to implement this feature, the forum module was chosen. It is one of the core modules that come installed in Drupal. Furthermore, it was configured according to the requirements of the website. The forum is divided into five main sections. There is a section for each type of diabetes, a general discussion section, a diabetes management section and a diet section. These sections were created based on the outcome of the literature review and on what users were found to use the most on existing forums.

Private messaging:

Users can send private messages to other authorised users and doctors on the system. This is done to create a community feel beyond the forum and the discussion about diabetes. It aims to create relationships on personal level between the diabetic users; thus, making life with diabetes easier for those users and giving them an emotional support in knowing that there are many others living with diabetes.

Statuses:

Users can share statuses on their profiles and follow other users' messages. This will allow users to express themselves and connect with others in a more personal way. They can share messages, photos, links and videos on their status. The status box grows automatically using a jQuery auto-grow plugin. Furthermore, the module twitter was configured to provide API integration with the twitter micro-blogging service. This will allow users to associate one or more twitter accounts with their Drupal user account, and/or log in via their twitter account. This was done to connect the existing community on twitter with this web-based community. As some statistics show, Saudi Arabia ranks second in a list of the most twitter users in countries of the Middle East[27]-[28].

Logging in Using Social Networks:

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[27] http://www.arabnews.com/news/452204
[28] http://www.arabnews.com/news/455895

This feature gives users the option to login using their existing accounts in one of the big social networks (Facebook, Twitter and Google), instead of creating a new account using their email addresses. This was implemented to encourage users to use the website and to simplify the registration process for them.
It was implemented using the Social Login and Social Share module, which is an external Drupal module. It runs on LoginRadius which is a software service that allows users to bypass the typical registration process and log directly into the website using their accounts on popular social networks such as Facebook, Google, twitter and others[29]. This aims to increase the number of users on the web-based system.

5.4 Issues Encountered:

Even though Drupal provided most of the functionality needed for this project, it still had its drawbacks.

5.4.1 Translation of design into Drupal:

One of the challenges faced while using Drupal is the translation. The system is targeting Saudi and Arab patients. Therefore, it should be in written in Arabic. However, Drupal does not offer an official translation of its modules. Nevertheless, it is an open-source CMS; thus, there are volunteer translation teams. The Arabic translation provided by the Arab translation team on Drupal was downloaded and integrated with Drupal. Unfortunately, it was poor and inconsistent. Most of the core modules were still not translated and other modules were not translated either. Therefore, in order to translate the system, the developer joined the translation team. Moreover, the system was manually translated from both the administrative view and the code. Now, the system is translated except for a few strings that were hard to find. Furthermore, the translation which has been done will be added to the official translation group on Drupal for future developers.

5.4.2 Problem with Modules:

Drupal is an open-source content management system. This led to some problems in the development of the project. Some of the modules that were needed for the system's features were still in beta mode and others were suspended. Moreover, some dependent modules were not compatible with the current Drupal version. This resulted in a lot of unit and regression testing to ensure that the available modules conform to the design's needs.

5.5 Usability:

The system was built on usability standards. Features such as text resizing were implemented in this phase.

Text Size

The system provides the user with the ability to adjust the size of the system's content according to their needs for better web accessibility.

Page Layout and Content

The system has a consistent look and feel of all its pages. The title, navigation bar and site map appear on all pages to allow the user to navigate through the website easily. Moreover, there is a control panel on the right-hand side of the page that allows

[29] https://www.loginradius.com/

registered users to view their messages, post on forums, create a log entry and view progress graphs. Also, they can view their completed goals and point scores appear on all the pages they visit.

5.6 Security:

To ensure the security of the system, Drupal Security Review module was used. This module runs a number of security checks and provides detailed information on how to fix any security issue that might exist in the system. The review resulted in some user authorisation issues and error messages that review unneeded information about the system. Both of those issues were fixed using the detailed information.

Moreover, the third party LoginRadius was checked for security issues as well. According to their website, when using their service to login to any other provider (Facebook, Twitter etc.), no one including LoginRadius can view or store the user's information.

Chapter 6. Testing and Evaluation

In this chapter, the system is tested using white box testing and black box testing techniques. It was also evaluated by a group of experts and by users.

6.1 Testing

Testing was carried out to ensure that all requirements were met and that the website is functioning as intended. Testing should be done to discover unseen errors and to ensure that the system is functioning as it should. As Dijkstra (1970) said *'Program testing can be used to show the presence of bugs, but never to show their absence'*[30].

6.1.1 White Box Testing

One of the white box testing techniques is unit testing. It is the process of testing the individual components of the project. It took place throughout the implementation phase and was performed by the developer. Therefore, errors were identified in their early stages and fixed before they escalate to bigger problems. After checking that individual modules worked on their own through unit testing [Table 6-1], regression testing took place to check that these modules work together as a whole.

Performing regression testing was helpful in this project because of the modular nature of Drupal. Any change in one module during the unit testing might affect other modules and lead to major changes. For example, the Webform module was used to create a form for users to log their test results. After that, several other modules including Charts module and FusionCharts were tested to output the Webform results in a chart form. However, this was not feasible. The FusionCharts version for Drupal 7 was a development release, which is problematic for both users and developers. Thus, it contained a lot of bugs and did not integrate well with Webfrom module to extract the results and present them in a chart form. Similarly, the Charts version for Drupal 7 was not a stable release. In fact it was released in a beta mode. Fortunately, creating a new content type for the logbook form instead of using a Webform solved the chart problem [Figure 6-2]. Furthermore, a view was created and was integrated with the module Google Chart tools to represent the collected entries from the new content type in a chart form [Figure 6-1].

Table 6-1 Unit Test Cases and Results

U.T.1- Log in as a new user: A new account should be created, and the user should be awarded 10 points and a badge for starting.
Result: The account was successfully created [Appendix A]. A welcoming message appeared and points were added to the user profile. An error message appeared because of the email. However, this should be solved once the system is hosted online as hosting services normally includes a free SMTP relay server.
U.T.2- Logbook entry: A logbook entry is created and points and a badge should be awarded to the user.
Result: A logbook entry was successfully created, and points and a badge were awarded to the user [Appendix A].
U.T.3- View Graph: User should be able to view a graph of his/her test results using the user control panel.

[30] http://en.wikiquote.org/wiki/Edsger_W._Dijkstra

Result: A graph successfully showed the test results [Appendix A].

U.T.4- Private messaging: User can send private messages to other registered users.

Result: Messages were sent back and forth between the two users. The user was also notified when a message was received [Appendix A].

U.T.5- Sharing statuses: User should be able to share messages and images on their status.

Result: User shared both a message and an image successfully [Appendix A].

U.T.6- Posting on Forum: User should be able to post on forums and get points for it.

Result: User posted on forum and got points and a badge [Appendix A].

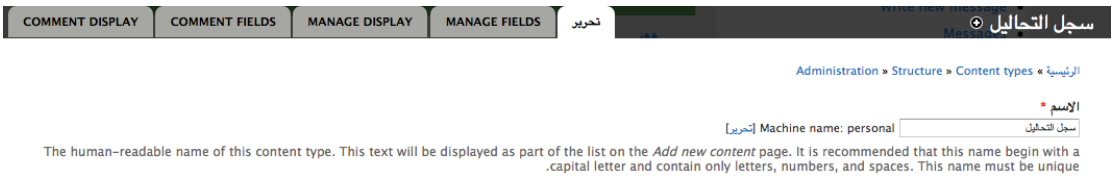

Figure 6-1 New Content Type for the Logbook

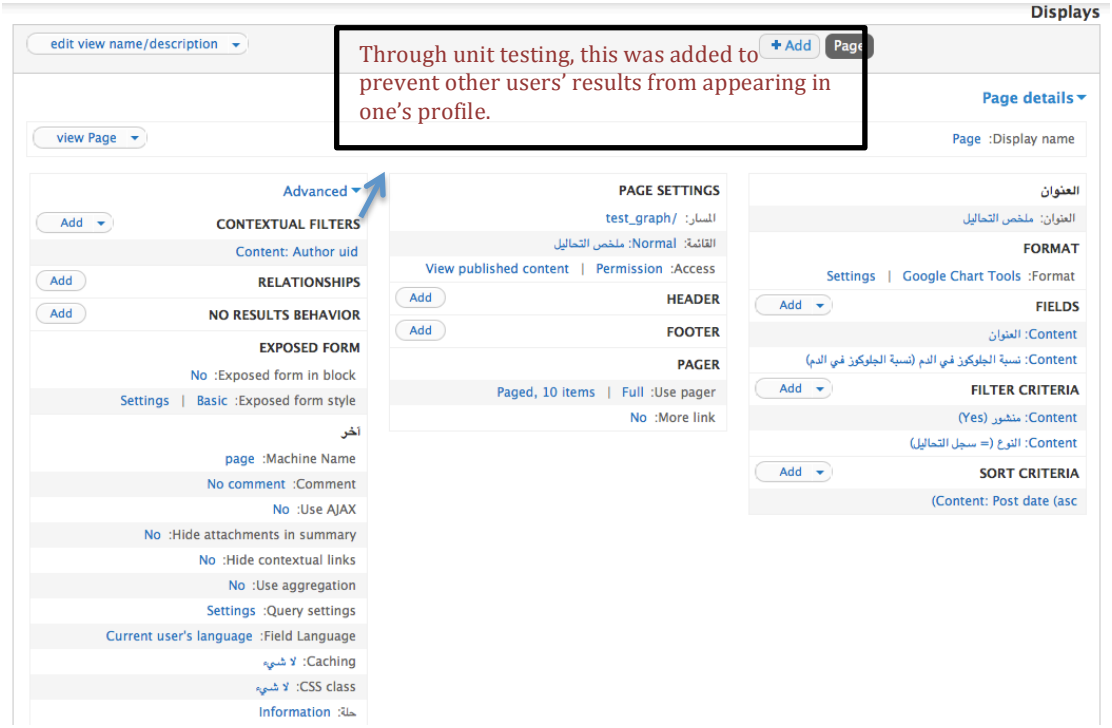

Figure 6-2 Creating a Chart for the Logbook

6.1.2 Black Box Testing:

Black box testing is another technique for testing the system. It treats the software as a black box without any knowledge of the internal aspects of the system [Khan and Khan 2012]. It was carried out to ensure that the system complies with the functional requirement list [Table 6-2].

Table 6-2 Testing the Requirements

ID	Name	Result	Evidence	Pass/Fail
F. R. 1	User Profile Accounts.	Each user has an account in the system with his/her information and contact details.	[Appendix A]	PASS
F. R. 2	Electronic Logbooks.	Users have logbooks for their blood glucose level tests and information associated with it.	[Appendix A]	PASS
F. R. 3	Social Network.	Users can interact with each other users using private messages or on the forum. They can also follow each other's status messages	[Appendix A]	PASS
F. R. 4	Gamifying the system.	Users are awarded for every logbook entry, forum post and other actions on the system.	[Appendix A]	PASS
F. R. 5	Chart test results.	Users can view a graph of their glucose level based on their entries.	[Appendix A]	PASS

6.2 W3C Validation

The W3C markup validation service[31], provided by the World Wide Web consortium was used to test the XHTML pages of the web-based system. It checks whether the documents have a well-formed markup. Few errors were found regarding some missing "alt" tags. However, these errors were fixed and the documents now are validated [Figure 6-3].

Figure 6-3 W3C Validation

6.3 Evaluation

The system was evaluated using a number of techniques. Questionnaires were formulated to evaluate the use of the system, and a heuristic evaluation was performed to evaluate the usability of the system.

6.4 Methodology

There are many tools that help developers understand the success and failure of any project. The Technology Acceptance Model (TAM) is one of these tools [Davis *et al.* 1989]. Both questionnaires were based on the TAM approach. It is a theory that evaluates how users accept a new system [Davis 1986]. TAM measures the acceptance of users from two perspectives; the perceived usefulness and perceived ease of use of the system. Perceived usefulness is defined as the degree to which users believe that the system will be useful to them, while perceived ease of use is the degree to which using the system does not require mental effort [Abu-dalbouh 2013].

[31] http://validator.w3.org

The questionnaire filled by the professionals was used to assess the perceived usefulness [Appendix B]. This was assessed by means of the content of the website and what it provides to Saudi and Arab diabetic patients. On the other hand, the users' questionnaire assessed both the perceived usefulness and ease of use [Appendix B].

6.4.1 Focus Group Evaluation:

A focus group of three doctors was contacted to evaluate the website. This evaluation technique is useful for the purpose of gathering and understanding the subjective perspective of a group of professionals toward the system. The doctors chosen for the evaluation were two diabetologists and a psychiatrist with experience working with diabetics. They had many years of experience in dealing with Arab diabetic patients. Therefore, they had an understanding of the problems which these patients have in managing their disease. Furthermore, it was essential to assess the effectiveness of the system from a psychiatric point of view.

The overall response received from the focus group was very positive [Appendix B]. According to expert #1, the idea of the system is very important. Moreover, he encouraged a thorough study of the effects of gamification in managing diabetes in the Arab community. Similarly, expert #2 assessment was very positive. She added that this is an excellent way to reinforce positive behaviour in managing diabetes. Furthermore, as a doctor who deals with so many young Type 1 diabetic patients, she indicated that Sukr would be effective on young patients. Moreover, she was excited to be part of the project and wanted to share it with her patients.

6.4.2 Users Evaluation:

Ten Arab diabetic patients anonymously filled in the user questionnaire [Appendix B]. They were asked to view a video of the system and answer a number of questions to assess its perceived usefulness and ease of use. According to the results, the respondents ranged between 18 and 25 in age, and over half of them were recently diagnosed with diabetes. Thus, they might find it difficult to manage. Furthermore, the results prove that the Internet is one of the main sources of information for those patients. What is interesting is that 42% of those who responded get their information from English websites. This might be because of the limited sources of official information about diabetes in Arabic. Surprisingly, over 80% of respondent did not have diabetic friends or just had a few. This might be the reason why 85% of them strongly agreed with the following statement *"Having an online community where I can get in touch with other diabetic patients is very helpful".*

On gamification, the majority of respondent believed that getting points for logging their test results would encourage them to keep on logging. Furthermore, 70% of them thought that competition would encourage them to post more and engage more with the system. Additionally, all respondent found that the points they would get from others for posting on the forum would encourage them to post more. Finally, the majority of respondents liked having the option to register using their existing accounts from other social networks.

6.5 Comparative Evaluation:

Although Gamification is still a new subject, there has been some research conducted on the effects of it in healthcare interventions and medication adherence. A number of studies have shown that social and interactive health games that help in the management of chronic diseases, improve self-care [Lieberman 2001; Feldman 2011].

Moreover, a study on children and young adults showed a significant reduction in diabetes related emergency situations by 77% after a trial of six months [Lieberman 2001]. Such positive results were also found in smokers who used gamified applications to help them quite smoking [Feldman 2011].

Furthermore, [Table 6-3] shows a comparison between the web-based system Sukr and three other similar systems. It shows a full circle when the system meets the criterion, a half filled circle when it partially meets the criterion and an empty circle when it does not meet the criterion. Moreover, the three systems are bant, mySugr, and Diabesties, which correspond to A, B, C on the table. "bant" is a an iPhone mobile application that targets type 1 diabetic patients [Cafazzo *et al.* 2012]. After performing a three-month long trial on 20 type 1 diabetes patients from both sexes, the results showed an improvement in the frequency of glucose monitoring [Cafazzo *et al*. 2012]. On the other hand, mySugr is also a gamified mobile application for managing diabetes but it could be used on both iPhone and Android smartphones. In addition, mySygr provides users with the ability to save pictures with every glucose test entry. In addition to awarding users points, mySugr has other gamified features. It sets challenges for users and awards them a free trial of the pro version of the application for a certain amount of time[32]. Lastly, Diabesties is a social application that is designed by Ayogo, which is a company that creates games and applications for healthcare[33]. Diabesties is a diabetes management application that allows users to save their blood glucose test levels and calorie intake levels. Moreover, users of Diabesties can share their test results with other users in a micro-blogging fashion. However, it does not reward users with points or badges on their action. It just focuses on the meaningful support that users would get from a one-to-one social network.

Table 6-3: Systems Comparison

Criteria	**A**	**B**	**C**	**Sukr**
Has a profile account for users.	○	○	●	●
Enables users to keep a logbook of blood glucose levels and related information.	◑	●	●	●
Has a community for diabetic patients (forums or groups).	○	○	○	●
Includes the use of gamification to motivate users and reinforce positive behaviour in managing diabetes.	◑	◑	○	●
Provides users with graphs of their test results.	●	○	○	●
Could be used across platforms.	○	○	○	●
Could be used by both type 1 and type 2 diabetic users.	◑	●	●	●
Allows users to save pictures with their test results.	○	●	○	●
Provides Arabic Language.	○	○	○	●
Provides one-to-one communication between users.	○	○	●	●
Provides micro-blogging features.	○	○	●	●

Based on the evaluation above, it can be seen that Sukr provides a lot of the required functionality compared to other systems. However, some the features that proved successful in these systems could be incorporated to within Sukr to make it more beneficial to users.

[32] http://mysugr.com/companion/

[33] http://ayogo.com/

6.6 Heuristic Inspection:

Heuristic inspection is an evaluation of the website's interface design for usability. Usability as defined by ISO 9241 is *'the extent to which a product [or website] can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use'* [ISO 2006]. In other words, it is the extent to which the website is easy to use by all users. Moreover, the website was tested against the 10 heuristics of usability formulated by Nielsen [Table 6-4].

Table 6-4 Usability Heuristics for User Interface Design [34]

No.	Principle
1	**Visibility of system status** Timely feedback should be provided to users on every action done.
Test Result	The system provides feedback for every action done. For example, when users register they will be provided with two messages, one indicates they have successfully registered in the system and the other presenting the points they earned for registration.
2	**Match between system and the real world** The language used on the website should be familiar to the user and easy to understand.
Test Result	The content of the system is written in a simple Arabic language to enable patients from Saudi Arabia and other Arab countries to use it without any difficulties.
3	**User control and freedom** Exits should be provided on every page. '*Supports undo and red*o.'
Test Result	The navigation links on the system provide the user with an easy way to exit or go to the links.
4	**Consistency and standards** The website should follow a platform convention. Thus, users would not be confused about the meanings of different words, situations, or actions.
Test Result	The system has a consistent look and feel to all the pages. Moreover, the navigation menu and control panel is available to registered users on all the pages.
5	**Error prevention** Problems should be avoided as much as possible. In the presence of an error the user should be presented with good error messages.
Test Result	Users are presented with clear and easy to understand error messages.
6	**Recognition rather than recall** Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.
Test Result	The system is easy to use and the idea behind it is clarified on the homepage. Once the user register there will be a navigation and control panel that provides the links which the user needs. Moreover, it appears

[34] http://www.nngroup.com/articles/ten-usability-heuristics/

	on all the pages to ease navigation.
7	**Flexibility and efficiency of use** Allow users to use short cuts and tailor frequent actions to their needs.
Test Result	Keyboard shortcuts can be used on the system.
8	**Aesthetic and minimalist design** The content of the website should be clear and precise without any extra un-needed information that could confuse the user.
Test Result	The content on the system is clear and straightforward.
9	**Help users recognize, diagnose, and recover from errors** Users should be provided with clear and precise error messages that suggest possible solutions whenever a problem occurs.
Test Result	The system provides good feedback when encountering an error to help the user to understand why it happened and how to solve it.
10	**Help and documentation** The website should contain a page that explains the purpose of the website and its features. It should also allow the user to ask for help whenever they need it.
Test Result	The homepage explains the purpose of the website. There is also a "Contact Us" page for users to clarify any questions which they have.

Chapter 7. Reflections, Future Work and Conclusion:

This chapter provides a critical reflection on many aspects of the development of the system.

7.1 Journal

The process of designing and implementing this project was very important to me. Having friends and family with diabetes I had an initial understanding of the difficulties which they have in managing their condition. However, I realized the magnitude of the problem in Saudi Arabia and other Arab countries after immersing myself in the literature about diabetes and other related topics. This gave me the incentive a push to work harder and implement the project and finally take it live.

Furthermore, each phase of the development process has presented an opportunity to grow the acquired skills from the program as well as to develop skills in new areas. One of the most important skills that was needed to successfully complete the project is time management and organization. This is because the process of researching, designing and implementing the project required commitment as well as critical and analytical skills.

Learning about gamification and its application in the health field and in helping others installed in me a thirst to learn more about it. Furthermore, this project allowed me to learn and use new technologies as well as apply the skills which I acquired throughout this program.

Finally, the dissertation process has improved my confidence in my ability to transform the skills and knowledge I had to a project that could help others. Now, I am excited and motivated by the prospect of continuing my research on gamification and behavioural theories and applying it in many areas.

7.1.1 Tool Selection:

A number of content management systems (CMS) were evaluated in order to select the implementation tool used for the project. The main criterion for this evaluation was the support for the gamification techniques designed for Sukr. The final choice was between two CMS, Drupal and MonoX. Furthermore, Drupal is an open-source CMS that is PHP based. On the other hand, MonoX is a free ASP.NET CMS. Both CMSs have a full support for gamification and social networks, which are important factors in the design. However, Drupal has been around longer that MonoX and has had a very active community. This was especially important because the developer had no previous experience with PHP or Drupal itself. Furthermore, Drupal supports all the other features of the system. It is also feasible for future improvements. Thus, it was chosen to be the tool of implementation. Finally, this was a chance for the developer to learn a new language and get experienced with the new tool.

7.1.2 Future Work:

The project has successfully achieved its entire set of requirements in the assigned time. Moreover, it was evaluated by experts in the field and by users for its perceived usefulness and ease of use. However, it could be studied in greater detail and be

improved and expanded in the future. An outline of future work and evaluation plans was constructed.

Evaluation:

The system is designed to help diabetic patients in managing their disease. It acts as a management tool and a social network for Arab diabetic users. The main feature of the system is the use of gamification to influence user behaviour, which is done by rewarding users on certain tasks such as recording glucose level tests at least three times a day. This aims to reinforce positive behaviour in self-managing diabetes. Thus, the system must undergo a three-month or longer trial to study the effects on patients of the Arab community. Factors such as the effect of rewards in attracting users and giving them motivation to continue on recording their tests and communicating with others on the system, and the effect of being part of a community and receiving support from others on the mental health of diabetic patients should be studied. Furthermore, the effect of the gamified system on the glucose levels of its users should be studied as well.

Improvement and Expanding:

The implementation of the project must evolve and improve with time. Inevitably, the goals and levels of the system would expand and increase according to the results of the trials and as the project and its audience grows. The system could offer a redeemable point system and create a badge shop. This would allow users to collect points and buy badges with them. A similar redeemable system was constructed on *"bant"* a gamified application for diabetes. Furthermore, a graphic designer could be contacted to design badges that are inspired by the Saudi and Arabic culture to relate more to the patients. This would enable users to value these badges more and relate to the system as a whole. Finally, working with a charity group for diabetes in Saudi Arabia is one of the future plans. This would help in marketing the project to a large number of users. Moreover, the input of experts in the charity group would be a positive influence on the project. Thus, Doctor accounts could be given permission to write and share articles. Finally, the system could be a hub for Arab diabetic patients. Linking the system back to other official diabetic websites would also help to provide the user with official and accurate information about their condition.

7.2 Management

The developer followed a strict plan that was constructed at the beginning of the project. The development life cycle took place in a fourteen week's span between 3rd of June and 6th of September. As shown in [Table 7-1], the development process was divided into eight major tasks. Each task was assigned a starting time, ending time and a contingency time. On the table, the black highlighted areas show the initial plan for the project, while the purple coloured areas indicate the actual progress. All milestones were met and the project was successfully completed during the assigned time.

Table 7-1 Project Schedule

Week #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Literature & background Review														
Actual Progress														
Requirements & specification														
Actual Progress														
Analysis														
Actual Progress														
Design														
Actual Progress														
Implementation														
Actual Progress														
Testing														
Actual Progress Time														
Evaluation														
Actual Progress														
Writing-up														
Actual Writing-up														
Demonstrate the project												×		
Dissertation draft complete													×	
Final corrections														
Hand-in														×

7.3 Conclusion

During the fourteen-weeks allocated to the project, a gamified management tool and community for Arab diabetic patients was designed implemented, tested and evaluated. A through research and justification of the project occurred in the initial stage of the project. Moreover, background research of similar tools and technologies was conducted.

The project is about creating a management tool and a social network that helps diabetic patients. The system is targeting Arab patients because of the lack of such projects in Arabic. Another important factor for choosing the Arabic language for the system is the increasing numbers of diabetic patients in the Middle East. In fact, Saudi Arabia is ranked 7th in the top 10 countries where diabetes is most prevalence. Seven other Arab countries are on the list as well. This is shocking and measures should be taken to take care of it. The project Sukr comes into play in terms of helping Arab diabetic patients to manage their condition and get the social and emotional support which they need. The system uses game techniques to assist in helping patients to manage their diabetes. The

positive motivation and support provided by the gaming aspect is there to reinforce positive behaviour in managing diabetes. These include keeping a record of daily tests and being aware of one's progress. Thus, it allows the patient to realize any patterns and make decisions accordingly.

The system was evaluated in several ways. A focus group evaluation was conducted to get the insight of doctors who deal with diabetic patients daily. The overall response was very positive. Doctors think that the project would benefit the Arab patient. In addition to the focus group, a user questionnaire was filled in by Arab diabetic patients of different ages. The overall response was very positive as well.

In the future, a study of the effects of gamification in managing diabetes in the Saudi Arabia and the Arab community should be conducted. The aim of this study is to evaluate the effects of rewards on the Arab community. Moreover, the results of this study should be reviewed in depth to enhance the system.

In conclusion, throughout this project a management tool and a community for Arab diabetic patients was designed and implemented. The new concept of gamification was successfully implemented as a main feature of the project. It was used to reinforce positive behaviour in managing diabetes. Moreover, this gamified web-based system take advantage of the psychological evidence of using rewards to reinforce positive behaviour.

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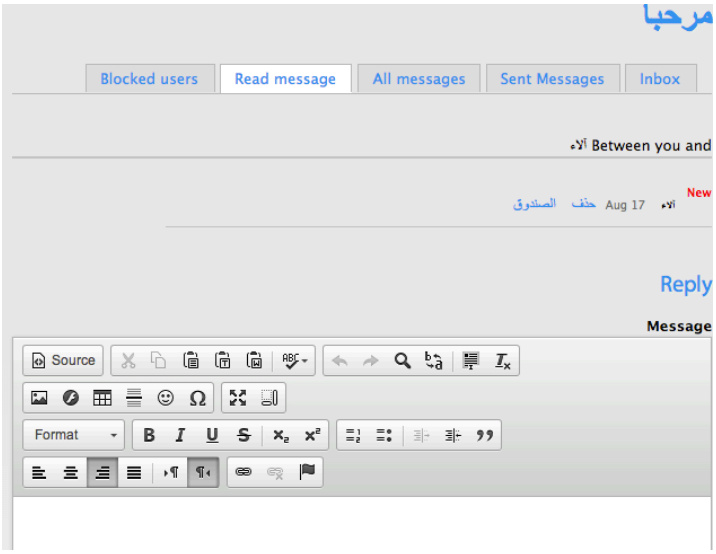
Appendix A

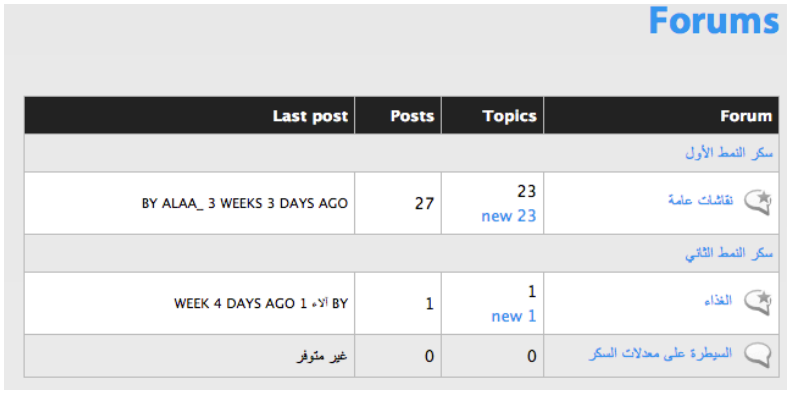
Black box testing:

F.R.1

F.R.2

F.R.3



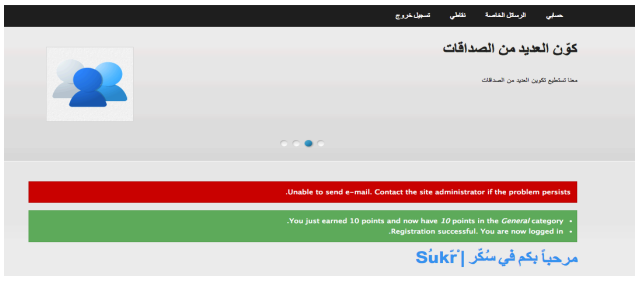


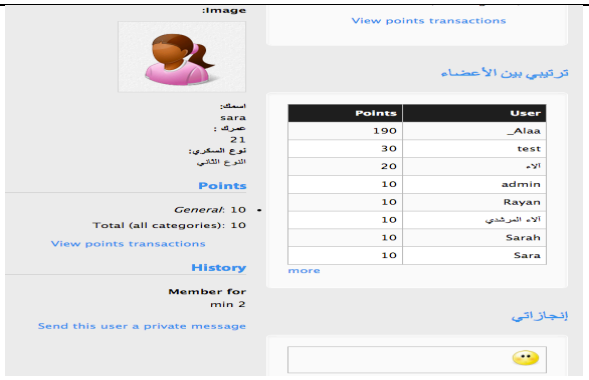
F.R.4 [Figure 4-12] [Figure 4-13]

F.R.5

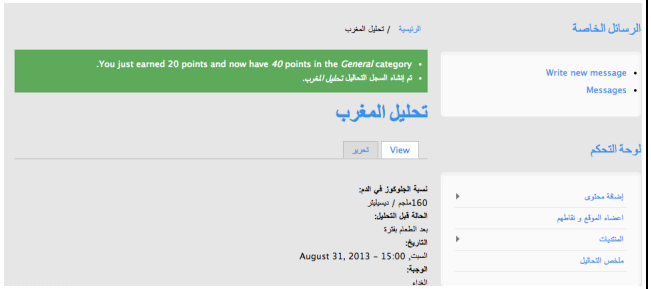
Unit Testing:

U.T.1



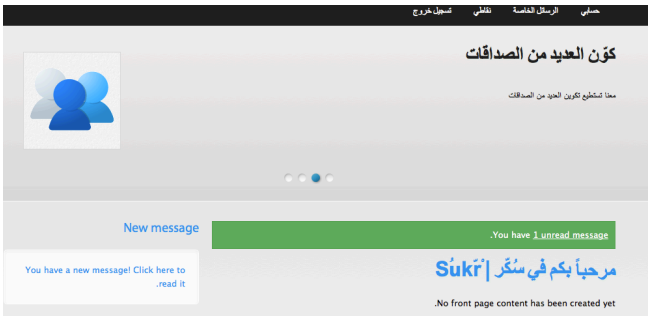


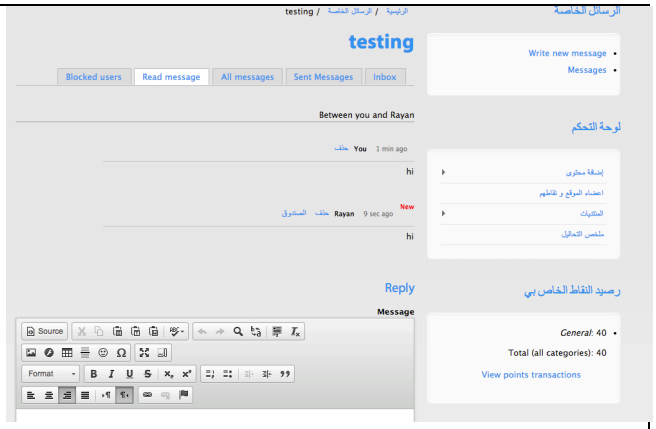
U.T.2



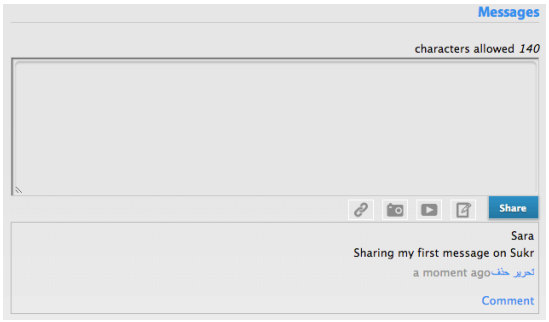
U.T.3

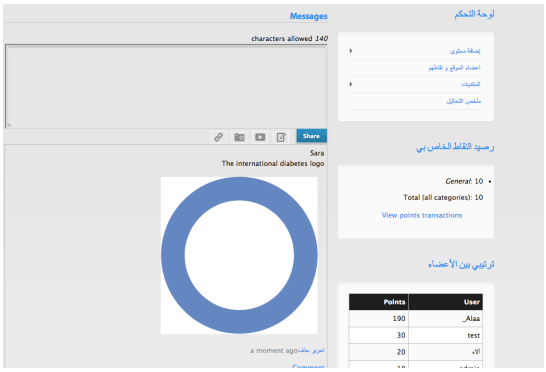
U.T.4



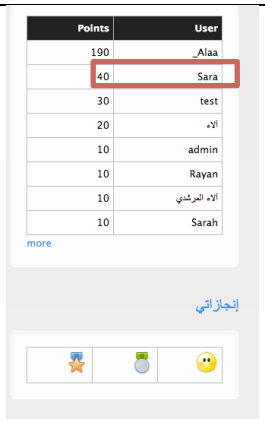


U.T.5





U.T.6



Points	User
190	_Alaa
40	Sara
30	test
20	الاء
10	admin
10	Rayan
10	الاء المرشدي
10	Sarah

more

إنجازاتي

Appendix B

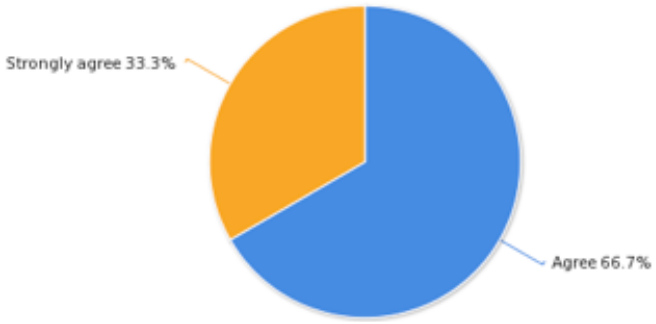
Focus Group:

1. Expert #1 from the college of medicine and teaching hospitals at King Saud University.
2. Expert #2 from Al-Habib Hospital in Riyadh, Saudi Arabia.
3. Expert #3 from King Saud University.

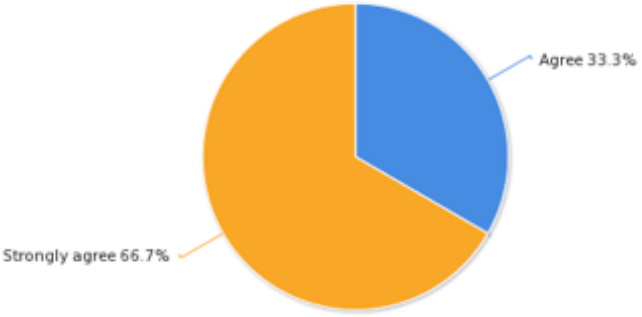
Doctor Questionnaire and Results:

1. Using reward systems can be effective in managing diabetes.

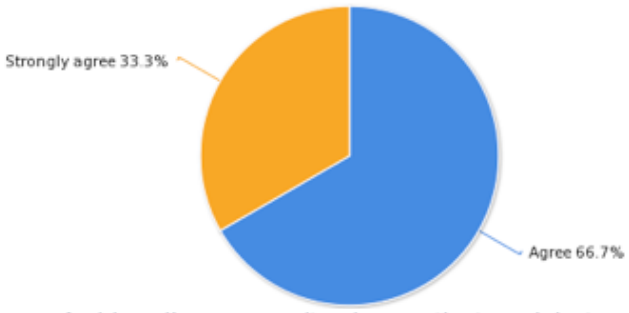
2. Awarding users for logging their test readings would encourage them to keep a record of their tests.



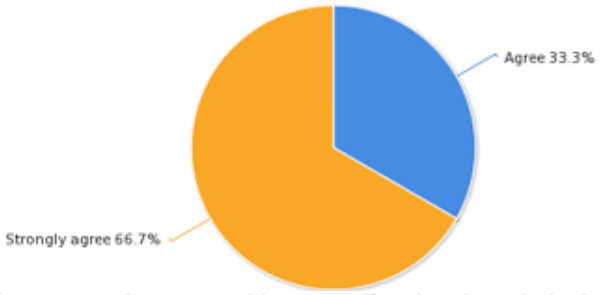
3. Showing a graph of the user's logged data help them to realize patterns in their condition.



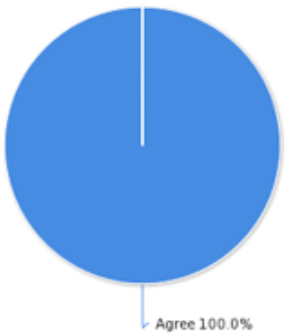
4. Positive motivation can have a profound psychological impact on patient's self-management of diabetes.



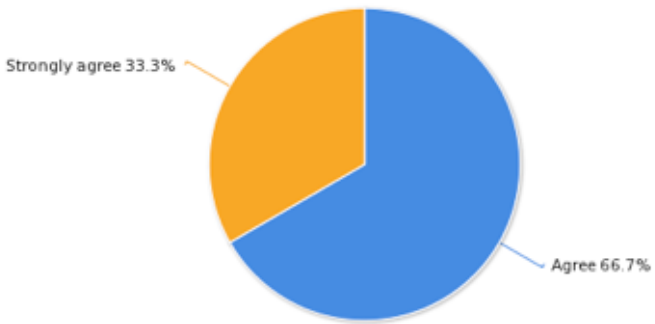
5. Having an Arabic online community where patients and doctors can exchange information will benefit the Arab patients.



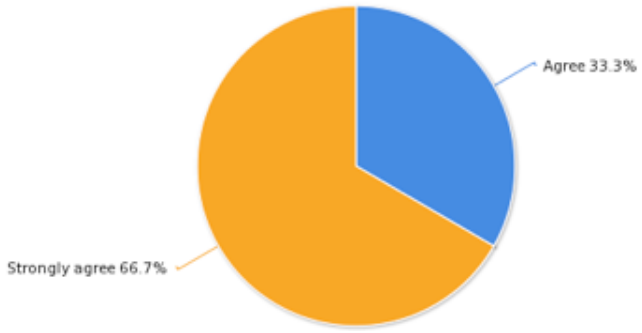
6. An online community can provide an emotional and psychological support for diabetic patients.



7. Having volunteer doctors monitor the forum is crucial to prevent wrong information from circulating between users.



8. Being in a community helps diabetic patients in coping with their condition.



Expert #1 Commented:

9. Comments:

I think the program idea is very important.However, this need to be tested in Arabic community befor applying it as a final program. I support going ahead with the program

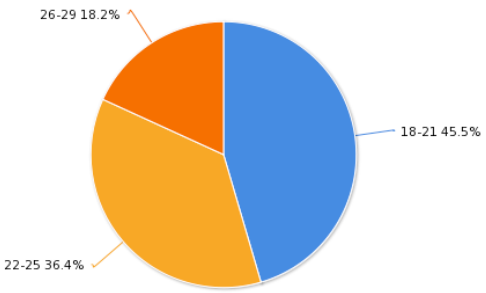
Expert #2 Commented:

9. Comments:

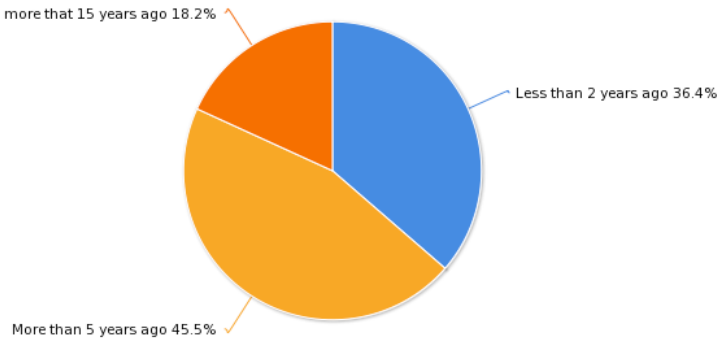
Its an excellent and encouraging way to reinforce positive behavior in managing diabetes especially in young and middle age patients in our community ,and the records can be reviewed even by diabetic educator under the supervision of the doctor to provide help to as much as large scale of patients
I am excited to be one of the doctors to try it on my patients to provide better help for diabetic patients in our community.
.

User questionnaire and Results:

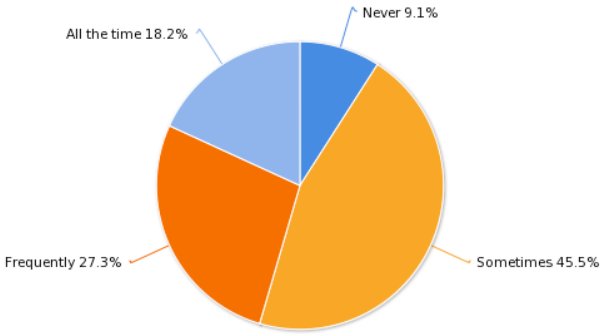
1. Choose your age group



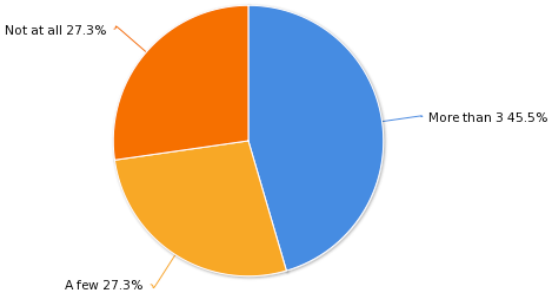
2. When were you diagnosed with diabetes?



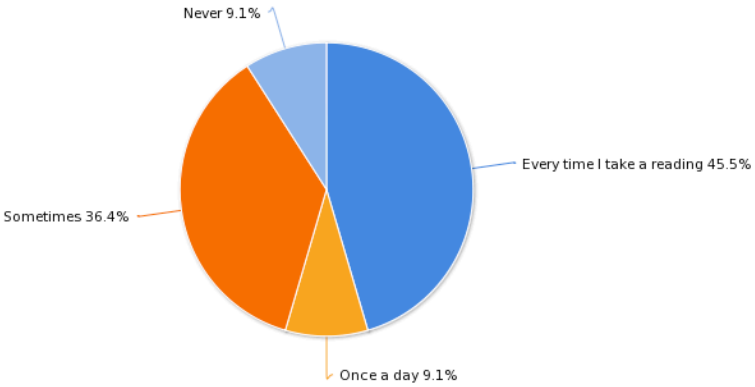
3. Do you use the Internet to search for information about diabetes?



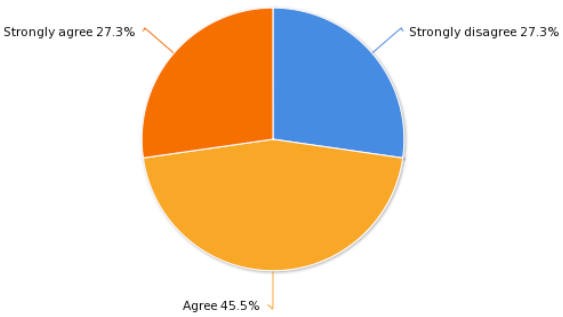
5. Do you have any friends who have diabetes?



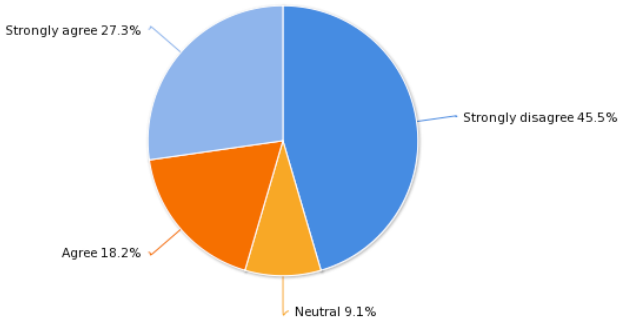
6. Do you log your diabetes information manually?



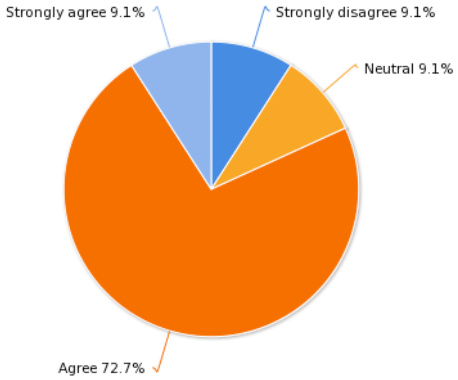
7. The registration process was easy.



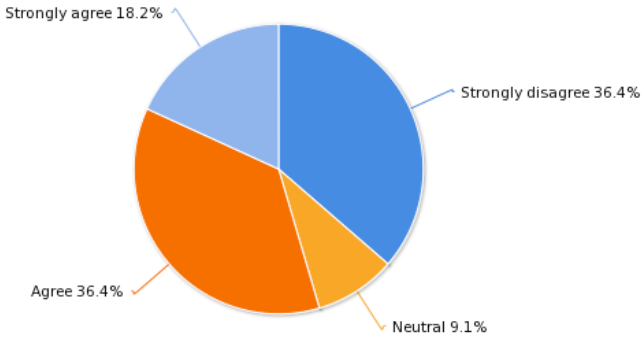
8. I like having options to register using several social networks.



9. Getting points for logging my tests would encourage me to log everyday.



10. Competition would make me more persistent in logging my test results and achieving higher levels.



12. Having an online community where I can get in touch with other diabetic patients is very helpful.