A playful interface for children’s diabetes self-care

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Abstract
This paper presents a portion of a web- and mobile-based soft- and hardware framework aiming to help children manage their diabetes in a more integrated, playful and rewarding manner.

The complete framework uses methods from the fields of web-based and mobile communication to create a network of participating stakeholders helping to manage young patients‘ diabetes, and it applies methods from the areas of serious gaming and gamification to encourage and support children in their tasks.

This paper briefly describes a first step towards this overarching project framework, the state of diabetes monitoring and sensor developments, and the outline of early interface concepts for such a diabetes self-care system.

Introduction
Diabetes mellitus is a widespread incurable disease in almost every country. Together with Diabetes-induced complications the disease results in increased mortality and morbidity rates, which is of substantial interest in health care management on a global scale. Recent statistical models predict an progressive development from 366 million people in 2011 to 552 million people in 2030.

In the long term, the economics of each health care system is affected directly by the strategy on dealing with this disease during a patient’s life. A continuous medical treatment of Diabetes mellitus from the beginning reduces the risk of secondary complications significantly. A continuous monitoring of the health status of each diabetic patient is of interest to evaluate the quality of their medication. A personal plan will prevent the evolution of secondary complications. Furthermore, the monitoring of various, Diabetes-related vital signs, e.g. during or after sport activities, allows an adaption of the medication on a short-term basis.
Especially during childhood this is of great importance: A device, combining monitoring and automatic adjustment of the medication for children's diabetes self-care and being embedded in a larger network of connected stakeholders and a gamified user experience suitable for children, would be an essential health care instrument.

**A framework for diabetes self-care**

This project is a subproject of a larger CARPE research project “Framework for diabetes self-care – Towards a user-centered, gamified diabetes monitoring, information and management framework for varying, specific target groups from children to elderly people”, planned by participants of Polytechnic Turku, Hamburg University of Applied Sciences and Manchester Metropolitan University. It consists of six work packages:


![Figure 1: Project structure and work packages.](image)

1. An analysis of existing and upcoming diabetes diagnosing systems and other related hard- and software. Focus on user-friendly and unobtrusive solutions. The technical requirements for the development of the sensor system will be evaluated and a suitable sensor solution will be proposed.

2. A framework and network system to log diabetes patients’ diabetes data and to connect patients, doctors and clinic personnel involved in the diagnosis of diabetes, caretakers and educators providing support and education to diabetes patients, family and friends of patients and other patients to a small “buddy” network around diabetes patients.

3. The web- and mobile-based, gamified software experience outlined below.

4. The creation and editorial of a content layer for the section “teaching and help section” above. It is understood and planned to tailor this content specifically for different target groups, e.g. children from 6–12, teens, twens, adults or elderly people. Depending on the final scope of the project, some or all of these content modules will be produced.
5. All segments will contain portions of early user-research, prototyping, testing and refinement of solutions.

6. The evaluation and dissemination of the outcomes, likely in field tests with user tests, followed by publication of the results.

**Diabetes Monitoring Techniques**

The main priority for monitoring the health status of a diabetic patient is measuring the glucose level in the human blood. The challenge of online diabetes monitoring is an ongoing task over the last decades. The most common method for precise glucose level measurement is done by finger-pricking and subsequent analysis of the blood with an external device. Besides medical reasons, i.e. the risk of infection, the user acceptance of this invasive method is its main disadvantage.

A continuous monitoring requires non-invasive detection methods, which are very promising with respect to user acceptance and real-time medical advise and treatment, if needed. The progress in the development of non-invasive glucose measurement sensors is related to the evolution of micro system technology over the last decade. Promising approaches are based on optical spectroscopy or electromagnetic resonance measurements. Even though some prototypes and pre-production designs are developed and in testing, commercial non-invasive sensors with a precision of only a few mg/dl are not yet available on the market.

Using micro system technology, the goal of development could be for example a wrist watch including a non-invasive detection system, which transmits the data using Bluetooth or by mobile phone networks. Data can be displayed directly on the device and on the larger displays of PDAs, tablets and desktop computers. Via cloud-based internet services, the data can become the basis for further “digital storytelling”, explained in the next section.

**A holistic, “gamified” user experience**

This segment, roughly the parts 3 and 4 of the complete project, develops the user experience for the communication between the stakeholders and the gamified visual and acoustic feedback for the little users. Parts of the functionality, style and the gamified elements are inspired by existing training and monitoring applications, most notably Nike’s NikePlus program. Other elements will draw from e- and playbooks for children.
The NikePlus program consists of several devices tracking runners’ performances. This data is collected and transmitted to a web-based community. In it, runners playfully compete with each other for points and prestige. From time to time, the system automatically generates witty “calls to action” to further motivate the participants. The whole system is a perfect example for a carefully and holistically designed enjoyable and engaging soft- and hardware experience. It is particularly important to note how carefully the hardware and software components are intertwined, how little intrusive the hardware is, and how the whole user experience is built around layers of “gamified” actions and storytelling.

Much of this best case can also be applied to our solution. Our solution aims to log diabetes patients’ data with a small wearable device. It aims to provide support and education to diabetes patients, and to connect patients, doctors, caretakers, educators and friends and family of the patient to personal “buddy” networks.

The planned software will consist of four main sections:

1. The account data of a user.
2. A teaching and self-care section designed to help the patient learn to learn the self-diagnosis and the management of his/her diabetes condition.
3. A “management” section. This segment displays all relevant patient and communication data and translates them into clear calls for action. It also features diagrams, statistics and the design of game-like applications to encourage the patient.
4. An emergency alarm, triggering help automatically or semi-automatically.

The sections 1 and 4 are with 10% each fairly small and straightforward. The main part will be the sections 2 and 3 with roughly 40% of this work package each.

The core idea behind the design of a health monitoring solution for children is to wrap the whole user experience with its tasks and interactions into a story and narration that gives the mundane
tasks of controlling abstract values a deeper meaning and adds both small sub-goals and a clear (albeit perhaps distant) main goal. Additionally the actions of the children are embedded in a community of friends, family and helpers. This can be visualized more or less realistic, depending on the children’s and the game designers’ preferences.

The act of monitoring health data gets transformed into a parallel narration with higher relevance to the patient. Like in other serious games or gamified applications, e.g. the house cleaning challenge “ChoreWars” (www.chorewars.com) or the real-world game “Ingress” (www.ingress.com), the fairly boring real-world tasks are supercharged with a sporty competition, additional and/or alternative meaning and “higher” goals along the way. In the following we sketch out three design suggestions.

1. Bandai’s “Tamagotchi”, a “software creature” in a little key ring plastic toy, was an early avatar for children. The creature needed constant attention and specific actions at specific times to live and prosper. This model could be transferred to a entity living in the diagnosis device and/or the online portal.

![Figure 4: Bandai’s “Tamagotchi”, a “living” toy creature. Shown here version 4 of the toy.](image)
2. Rewards for great “runs”. Games like “Guitar Hero” or “Temple Run” use simple mechanics for games along endless vertical bands. The diabetes monitoring data could be translated into the “moves” in such a game. This would add an incentive to keep an avatar or other play token in the safe “middle ground”. Failure to do so shouldn’t lead to discouraging ramifications.

![Figure 5: Graph of daily monitoring data. The white corridor indicates safe values, above and below are critical values (left). The video game “Temple Run 2” by Imangi Studios (right).](image)

3. Badges for completed quests and learning successes. This can be used both in the learning sections and in the management of the diabetes itself. Like in learning games or role-playing games, the participants can earn badges and points for completed “quests”. These can include little educational games or turn the monitoring itself in a game, for example by awarding very punctual tests or by keeping the value close to an agreed goal over a long time.

**Conclusion and Outlook**

This discussed briefly the challenge of an interface for diabetes self-care especially designed for children. In a short overview we described the software framework and the derived work packages. The different technical methods for sensing the diabetes status are discussed regarding the overall implementation in the software framework. Different options for the main software interface are evaluated and linked to existing cross-platform solutions in the field of data loggers for sports activities.

So far, the remaining work packages have only been loosely attached to specific work groups. As the next steps we plan to assign them to several CARPE teams, and to apply for funding to quickly develop them further. There’s a promising array of fitting funding programmes for this, including the EU Horizon 2020 programme (ICT 21 – 2014: Advanced digital gaming / gamification technologies, and others).
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