# Healthify: Motivating students to live healthier

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***Abstract*—In this paper the design, implementation and evaluation of a mobile application, called Healthify, is explained. This application is created to do research on if and how students between 18 and 29 years old, who are the main contenders to become overweight, can be motivated to live healthier by using gamification-elements like badges, leaderboards and sharing on social media. Throughout the evaluation of the different prototypes it became clear that the input of data should be very easy for the end user. Afterwards the motivational value of the different gamification-elements in the design as well as the motivational value of the design in general is evaluated by two experiments with groups of students.**

## I. Introduction

Some of the leading causes of death in the United States are obesity, diabetes and strokes [1], which are caused by poor diet and no or not enough physical activity. The same trend exists in Europe where obesity is reaching epidemic proportions [2]. Strokes are even the second leading cause of death worldwide [3].

Deliens et al. [4] indicate that the steepest rise in obesity, the period in which the most people get overweight, is situated between the age of 18 and 29 and mainly with people in higher education, meaning students. Not only the fact that obesity is linked to many diseases, like cardiovascular diseases, strokes and even some cancers [5], but also the existing positive correlation between health and academic results [6], are reasons for students to consciously engage with their personal health. Together with rising medical costs and the aging of society [7], this argues for a more preventive approach to public health.

Such a preventive approach can be obtained by people keeping an eye on and maintaining personal health themselves, by using something that is called Health 2.0 [8], which is comparable to Web 2.0, where users can also upload their own data, instead of only downloading content [9]. This means preventing diseases by preventing obesity consists of two parts. On one hand, people have to keep track of data about their health, but they also have to engage in improving their health when the data indicates their not living healthy enough to prevent getting overweight.

This research studies how people, and specifically students, can be motivated to keep track of and possibly improve their personal health by using a design, called Healthify, that lets people quantify themselves. Quantified Self[1], as the movement is called, has many advantages. For example, people that are keeping track of data about certain aspects of their life, in this case about their personal health, can gain insights about that part of their life, by analyzing the data afterwards. What they track may vary from calorie intake to number of cigarettes smoked to blood pressure or heart rate.

## II. Goal

The goal of Healthify is to motivate students to live healthier. These students are between 18 and 29 years old and study and live in a student city, like for example the Belgian city of Leuven. Living healthy is defined as eating more fruit and less food with a high amount of fat and being active at least 30 minutes a day for most days in the week [10]. To keep track of how healthy a student is living, data about food intake and activities is needed.

Every application that needs to motivate its users has to integrate elements in its user interface that increase the engagement with the user [11]. One way to do this, is to present the information in an intuitive and meaningful way, which makes it obvious which action(s) the user has to undertake to make progress or at least to not deteriorate. On the other hand, the user can also be motivated through social media and gamification-elements [12], like badges and competitions between friends [13].

## III. Related work

A lot of applications, which help users keep track of their calories, already exist. By comparing them, strong points as well as flaws can be identified and can be respectively used or avoided when designing Healthify. The applications that were compared are MyFitnessPal[2], LiveStrong's MyPlate[3], Calorie Count[4] and Fitbit[5]. These applications were chosen because they are amongst the most used applications in the domain of personal health.

By first drafting some criteria for comparison of the chosen applications, it is easier to identify the strong and weak points of each application individually as well as to see what all applications do and don't have in common. Examples of the used criteria are methods of getting the data, use of goals and gamification, the posibillity to add and communicate with friends and the integration of social media.

The main strong points of these applications are all applications, except LiveStrong's Myplate, track burned calories automatically and give users the possibility to add friends [14],[15] and that all applications give some advice about living healthy. Negative points are that the applications don't or

[1] http://quantifiedself.com

[2] http://www.myfitnesspal.com

[3] http://www.livestrong.com/myplate/

[4] http://caloriecount.about.com

[5] http://www.fitbit.com

barely use motivational elements that try to stimulate users to reach their goals [16] and only the Fitbit-application provides a connection to social media [17].

## IV. Design

The first step of the quantified self-process is capturing the data, which should have a minimal impact on the user experience with the application. There are two extremes for doing this. On one hand there is the complete manual input of data, which means the user is fully responsible for inputting all relevant data. On the other hand all data could be collected automatically, so the user is relieved of this task [18]. However, a combination of both extremes is needed, because not all burned calories can be tracked automatically and data about calorie intake are even harder to collect without help from the user. While it is obvious the user's help is needed in logging the necessary data, the user should be relieved as much as is possible, by making the input proces easy and fast [19].

By 2017 there will be more than three billion smartphones in the world [20] and according to a study of Dey et al. [21] these smartphones are 53% of the time within the reach of the owner and 88% of the time in the same room. This makes the smartphone the ideal medium to collect data about the everyday activities of their owners, because it can track some data automatically and it is within reach when the user needs to do the input manually.

To simplify the task of the user for logging burned calories Healthify provides to possibility to connect with a pedometer, which is an application that logs the amount of steps the user takes and the calories that are burned by doing this. If users are carrying their smartphone with them, it will automatically log how much calories they are burning without interrupting the users' day-to-day activities. The input of calorie intake can also be made easier by updating the user's location when he or she is moving around and checking if a restaurant or bar is in the neighborhood, so the user can be notified with a list of possible dishes and doesn't forget to log if he or she has eaten something. By connecting this automatic tracking of burned calories and using location info to make input of calorie intake faster and easier, the user is to a large extent relieved of the burden of pure manual input.

### A. Motivational elements

The research that is done, is mainly about how students can be motivated to live healthier. Lee & Hammer [22] indicate that gamification-elements in videogames are motivating because of their impact on the cognitive, emotional and social area of the players. If gamification is used in other fields than videogames, it should also focus on these three areas. The design, that is created for this research, tries to get motivation from two different sources. First of all, the design itself tries to motivate its users by providing a system of badges, that can for example be earned by eating fruit or doing exercise several days in a row. By awarding these badges immediately after a task is completed, the user is stimulated in the emotional area [23]. To motivate the user in the cognitive area, it is important to make sure users know what they have to do to earn a badge [24]. The social cognitive theory [25] and the transtheoretical model [26] indicate that the user needs

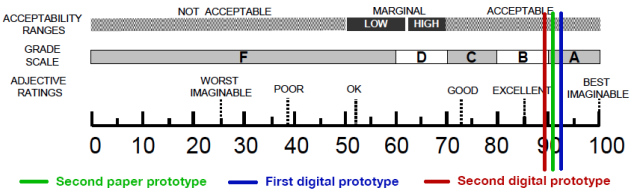


Fig. 1. The SUS-scores [34] of the different prototypes: the second paper prototype in green, the first digital prototype in blue and the second digital prototype in red

to believe that he or she is able to reach the goals needed to earn a badge, so the difficulty of badges should be challenging but achievable. This makes it possible to examine whether the use of these badges promotes a healthier lifestyle in a fun, but challenging manner [27]. Secondly, motivation can be obtained from the environment of the student. An example of this is that a competitive feeling can be created by the fact that users can see each others badges [14] and that badges can be shared via social media, which is a stimulation in the social area of the user [28].

## V. Method: rapid prototyping

To go from the original design to a working mobile application that is available for end users, an iterative method, called rapid prototyping, is used, because not all requirements are known beforehand and they can become clear during user tests. Through every iteration the usability of the application is increased by solving problems test users indicated in the evaluation of the previous iteration [29].

The evaluation of every iteration consisted of three parts. First, the test user was asked to perform a set of tasks, while using the think-aloud protocol [30], which is used to collect data from the short-tem memory of the test user which is preferable to thoughts from the long-term memory, because these are often changed by perception [31]. By knowing what the user thinks while performing a task, it is possible to determine which user interface elements cause trouble and what potential solutions are. Secondly, the test users were asked to fill in a SUS questionnaire, which is a quick and easy way to assess the usability of the application [32]. The results of a SUS questionnaire are translated to a percentage where a score of 68% is considered average [33] and all scores above 90.9%, which fall under grade A in Figure 1, are considered the best user interface imaginable [34]. Finally, in most iterations, the test users were asked some other questions, often about how they felt about a particular part of the functionality of the application or about their food or sporting habits. The answers to these questions where used to determine which features users liked and what could be changed so they would really use them. The test audience mostly consisted of students, because they are the target audience of Healthify. However, sometimes an iteration was also evaluated with users that didn't belong to the target audience, because they also could provide important feedback on the user interface.

## VI. Iterations

Five iterations were done to continuously increase the usability of the application, as shown in Figure 2, and to

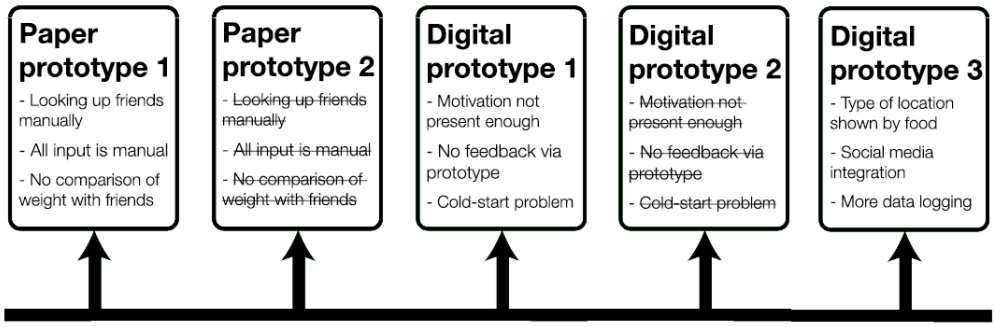


Fig. 2. A timeline overview of the different iterations. For each iteration the problems that arose during that iteration are listed. A problem being crossed off in an iteration means that that iteration solved the problem that arose in a previous iteration

come to a working application that would make it possible to examine whether the design was able to reach its goal, namely to motivate students to live healthier.

In the first two iterations a paper prototype was used, because a paper prototype generates almost the same quantity and quality of critical user statements as a digital prototype [35], while making it easier to identify and correct design mistakes early on in the rapid prototyping process. The last two iterations where done using a digital prototype to give the test users access to and get feedback on the real look and feel of the application.

As described in the previous section, all iterations were evaluated the same way. After the user tests were finished, the results were compared to identify problems with the user interface of the application, which was followed by a reflection on these problems to come up with different solutions. Finally a certain solution was selected for each problem and included in the next iteration, so the changed prototype could properly be tested to see whether the original problems were solved and if new difficulties arose.

### A. First paper prototype

The first paper prototype[6,7], as shown in Figure 3, was created based on a mindmap that was drafted after the comparison of different existing applications, as explained in the Section III, was done.

This first prototype was evaluated by seven students who where 21 or 22 years old and were all the owner of a smartphone. The most important problems were:

1) Looking up friends manually was devious
2) Input of food, activities and weight should be easier than just manually entering them
3) Some users also indicated they would find it motivating to compare their weight to other users

All other functionality was clear to the test users and most of them (6 out of 7) thought the use of badges and viewing friends' badges would be motivating to live healthier. A SUS questionnaire was unfortunately not carried out at the time of this iteration, which makes that some relevant information is lost in this iteration.

[6]http://thesisquantifiedself.wordpress.com/iteraties/
[7]http://bit.ly/first-paper-prototype

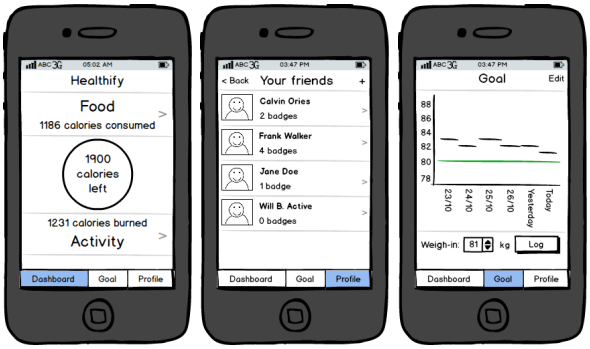


Fig. 3. Homescreen, screen with the badges earned by friends and screen with a visualization of the weight of the user through time, as they were in the first paper prototype

### B. Second paper prototype

The second paper prototype[8], as shown in Figure 4, tried to solve the issues raised by test users in the first iteration. There were three main differences between the first and second paper prototype. First of all, in the second paper prototype a Dutch food and activity database would be used, because this would also make it easier for the user to log data in their mother tongue, so it was obvious the whole design should be converted to Dutch. Secondly, to simplify the input of food, the location of the user would be used to determine whether he or she was in the neighborhood of a place where he or she could eat. When this is the case, a list of possible foods is proposed. To simplify the input of activities, a pedometer was connected to the design, so some of the user's activity would be logged automatically. Both these changes didn't have a big influence on the user interface however and the functionality they provide meant nothing in a paper prototype. They were however included to see how users felt about the functionality being present in the design. The last important change was the fact that notifications would be used to remind the user to log his or her weight and the food he or she has eaten. These notifications could be disruptive for some users, so the possibility to turn them off was also added to the design.

This second prototype was evaluated by nine test users, again all students between the ages of 17 and 23 and smart-

[8]http://bit.ly/second-paper-prototype


Fig. 4. Profile, adding food and activities and comparing weight to other users' weight, in the second paper prototype

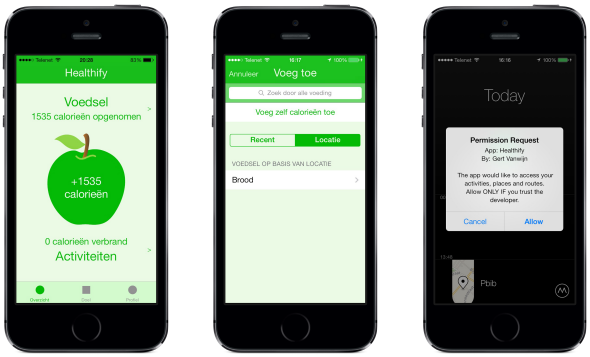


Fig. 5. Homescreen, food by location and connection with a pedometer in the first digital prototype of Healthify

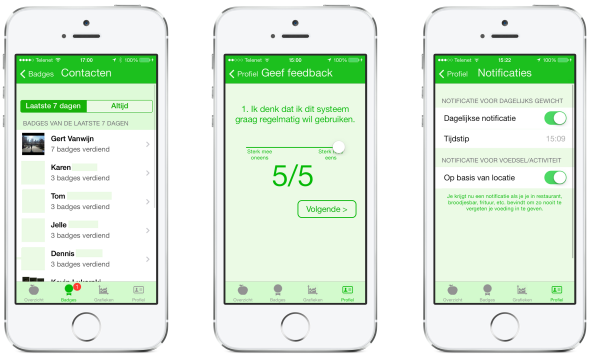


Fig. 6. Friends' badges, possibility to provide feedback and settings for notificatons in the second digital prototype of Healthify

phone users. The main problem that became clear during these iteration was that food and activities could not be added manually if they were not available in the database.

Most users (7 out of 9) also indicated that seeing other users' weight wouldn't motivate them, so this part of the functionality could be omitted in the next prototype. Positive was that almost all test users (8 out of 9) thought notifications were very handy reminders, again that badges and friends would be motivating and that setting a weight goal and the visualization of the progress toward that goal would also stimulate them to work towards their weight goal.

The average score on the SUS questionnaire was 91.9, which means the user interface falls under category A on Figure 1 and that the user interface is one of the best user interfaces imaginable for the design.

### C. First digital prototype

The second paper prototype didn't produce any major usability issues, so in the next iteration a digital prototype, as shown in Figure 5, was developed. Healthify, as the design was called by then, was mostly just the digitalized form of the second paper prototype.

This prototype was only tested by three students between 18 and 25 years old. After these three users the iteration was stopped, because the issues that arose would better be solved before testing was continued. So it would be wiser to first implement these changes and then testing again for other issues. The problems were:

1) The main goal of Healthify is motivation through badges and friends. This functionality should be more present in the application, instead of hidden in the user's profile
2) The user wasn't able to give feedback through the application. This would be a problem once the application was made available online and not each user could be contacted after using the application
3) Cold-start: the application was 'empty' when the user first opened it

The average SUS-score was 92.5, but keeping in mind only three users participated in this iteration, this number isn't really relevant.

### D. Second digital prototype

The second digital prototype, as shown in Figure 6, was the first version that was made available online[9] through Apple's App Store. At this point, Healthify contained enough functionality to be used as a real mobile application. A big difference from the first digital prototype was the fact that badges where in a separate tab with an indication on the tab when a new badge was earned. This ensured that badges were more present in the application as before. Also the possibility to give in-app feedback and add own food and activities to the database was added. The cold-start problem wasn't really solved, except for the fact that there is an extra add-button which draws the user's attention on the overview screens and the 'recent foods'-list is not empty when there aren't any recent foods. The list gets filled with different fruits now, which could encourage the user to actually eat more fruit. To be clear, the original food database in the prototype was not empty, it was filled with common food and dishes that are popular with students.

The second digital prototype was evaluated by nine students between the ages of 17 and 25 who were all smartphone-users. No big usability-issues arose in this iteration. The SUS-score of this prototype was 89.4 which is slightly less than the previous prototypes, but still in the top regions of the SUS-

[9]https://itunes.apple.com/be/app/healthify/id807479642?l=nl&mt=8

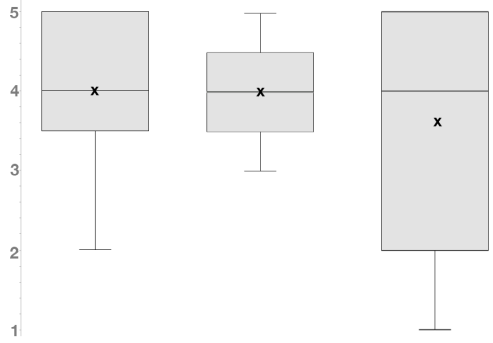


Fig. 7. Box plots of the responses to the questions from iteration 4: "The use of badges motivattes me to reach my goals and to live healthier" (left), "The difficulty of badges is well spread between easy and challenging (middle) and "I would like to share my earned my badges via social media" (right)

scale which mean the usability is still very good. This lower score is also due to one user who gave a feedback score of 75, without first even adding food, an activity or his or her weight. The feedback was given via the application, so no contact was made with this user, but it seems plausible the user didn't use the application before giving feedback and therefore this feedback is less valuable than the feedback from other users. Without it, the average SUS-score would be 91.3.

The users were also asked to reply to three other questions, which asked them about how they felt about the badges and sharing these badges on social media. The spreading of the responses to these questions are shown on the box plots in Figure 7. The responses on the questions about the motivational value of the badges were very positive (both questions had an average of 4 out of 5 points), which means users thought the badges were motivating and well spread between easy and challenging [27]. The responses about the connection to social media were rather divided, but tended slightly upward (average of 3.6 out of 5 points), so it was decided to implement the social media connection and evaluate whether this functionality is or isn't used when it is available for the users.

### *E. Third and final digital prototype*

Because no great usability issues were found in the previous iteration, the third digital prototype would also be the final prototype. The only interface-related changes in this prototype are the fact that the type of location is shown when users look for food at a certain location, which enables users to find what they are looking for faster and social media is integrated into Healthify, so users can share there achievements and can get feedback on them via social media, like Facebook an Twitter.

Furthermore a tracking functionality was built in, which means that everything a user logs, from food and activity to weight and sharing on social media, is stored and sent to a central database. These data will make it easier afterwards to evaluate how people used the application and if the gamification elements, that are designed to motivate them, really work.

Through the rapid prototyping process issues were raised and solved in each iteration to come to this third and final digital prototype. All the previous prototypes have helped to convert the original design into a fully-functional mobile application, which can be used by end users. This whole process was necessary to be able to carry out the evaluation that is described in Section VII.

## VII. Evaluation

All the previous work was done to create a prototype of the design, as explained in section IV, which could then be used to do research with students. The research, as was explained in section II, is about if and how students can be stimulated by gamification-elements to live healthier. The used gamification-elements are badges, leaderboards and sharing on social media, together with the simplification of the input-proces through presenting foods on location and automatic activity tracking.

To examine if these elements really add value to the design, so if the design with the gamification-elements really motivates the students more than without, there exists two possible approaches.

The first approach evaluates if students are motivated more to live healthier when using the design then when not using it. This is done by letting a group of students use Healthify for about 2 weeks and giving them a questionnaire before, after the first week and after the second week.

The questions in all three questionnaires are about their behavior, how they feel about the gamification-elements in the design and how motivated they feel by these different elements and in general. The responses to these questions together with all the data that is logged about the different foods, activities and badges, can create a greater insight in if and how the behavior of the different students has changed and why these changes have occurred.

The second approach focuses more on what the gamification-elements add to the design itself. By letting a group of students first use HealthifyOne, which is the exact same design as Healthify, but without the gamifcation-elements, so no badges, no food on location, no automatic activity tracking, no friends and no connection with social media, for one week and then letting them use the actual design with gamification, the value of these gamification-elements can be evaluated.

Again a questionnaire is given to each student before, after the first week and after the second week. By analyzing the data that is logged, as is explained for the previous approach, and the responses to the different questions, the value of the different elements can be determined and insights can be gained about which elements provides the most motivation and which elements have no or even a negative effect on the motivation of students to live healthier.

## VIII. Conclusion & future work

In this paper a design is proposed that tries to motivate students between 18 and 29 years old to live healthier, by using gamification-elements like badges, leaderboards and sharing on social media. Afterwards this design is converted to a mobile application, called Healthify, through the rapid prototyping process, which consists of the design, implementation and evaluation of a new prototype in each iteration. After this process was completed, the design, now implemented in a mobile

application, was ready to be used by the target audience, being students.

This whole process needed to be done to be able to evaluatie whether the integrated gamification elements were able to actually motivate students to change their lifestyle or to keep up their healthy lifestyle. Using the resulting mobile application two types of examinations are done to evaluate the motivational value of the individual gamification elements and the design in general.

At the time of writing the rapid prototyping proces, as explained in section V and VI, is finished and the evaluation, as described in Section VII, is underway.

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