A USER-CENTERED RESPONSIVE USER INTERFACE FOR FOSTERING STRESS AWARENESS

Implementation and Evaluation of the Web Portal Stila

Anna Hubert
Erklärung

Hiermit versichere ich, dass ich die vorliegende Arbeit selbständig verfasst habe und keine anderen als die angegebenen Hilfsmittel verwendet habe.

München, den 12. Juni 2018

Anna Hubert
Students experience a huge amount of stress during their studies and this stress is often perceived as very negative. However research shows that stress can be subdivided into positive stress (eustress) and negative stress (distress). Getting away from the ill repute of stress and thinking differently about stress can help to decrease pressure and to increase productivity.

The main objective of this thesis is to increase stress awareness among students in order to improve their academic life. Previous work focused on measuring computed stress based on heart rate data and user input. This work takes another approach and focuses on the psychological component of displaying computed stress by designing a user-centered user interface for a web portal, in addition to a mobile application as part of the Project Stila. The web portal provides access to detailed stress data and introduces the user to the different aspects of stress as well as an overview of the stress development over longer periods of time. The implementation of a Responsive Web Design ensures a positive user experience independent from the screen size of the device. The proposed layout and design are based on the results of analyzing different applications from the field of health and fitness. The color concept supports preattentive perception and aims at influencing the user’s feelings in a positive way. Additionally color and layout create an identity consistent to the application design.

A prestudy with paper prototyping provided early evaluation of the navigation through the web portal and a basis for the implementation of the redesign. After the implementation a group of students tested the web portal Stila as part of a field study to evaluate the new design. An evaluation showed that the redesign of the web portal is successful as the overall design proved more attractive for users due to simplified navigation, a deliberate color concept and comprehensible data visualization by the use of significant charts.
Zusammenfassung

Studenten sind während des Studiums einer großen Menge an Stress ausgesetzt und dieser Stress wird häufig als sehr negativ angesehen. Wissenschaftliche Untersuchungen zeigen jedoch, dass Stress in positiven Stress (Eustress) und negativen Stress (Distress) unterteilt werden kann. Vom schlechten Ansehen von Stress wegzukommen und anders über Stress zu denken, kann dabei helfen, den Druck zu verringern und die Produktivität zu steigern.


I would like to thank Prof. Dr. François Bry for giving me the opportunity to write this bachelor thesis at his chair and for offering valuable feedback on this project at the right times.

Special thanks go to my supervisor Yingding Wang, who supported me throughout the length of my thesis and encouraged me to put my ideas into practice. The frequent meetings were very valuable to me, especially the coding sessions that always lasted longer than planned but with a success in the end. M.Sc. Wang was always open for suggestions and had an answer to all of my questions.

I have to thank the participants of the prestudy and field study for participating and providing valuable input without which I wouldn’t have a fundament for my research.

Last but not least a huge thank you to my friends and to my family who showed a lot of patience while enduring the ups and downs during the time I was working on this thesis.
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CHAPTER 1

Introduction

1.1 Motivation

1.1.1 Stress in Academic Life

For all students, starting college is a huge change in their life. Leaving the protected school environment behind, they suddenly have to face completely new challenges. Students have to find their way through university buildings, pick their schedules on their own and manage how to learn effectively while finding new friends and even cope with personal problems. With the increasing number of college students, mass lectures with over two hundred listeners are common practice. Since universities have limited capacity of scholar and lecturers, caring for every single student’s needs is difficult. The individual student is only an anonymous number among many others. Due to the overwhelming tasks to achieve for, college entry students are exposed to pressure which often triggers negative emotions towards studying. Stress is a big issue in academic life and influences health condition significantly. Every living being is exposed to stress at almost all times, which is not necessarily negative [19]. The impact of stress on a person depends on the person’s attitude towards stress. Keller et al. show that a negative attitude towards stress while experiencing stress significantly increases the risk of dying prematurely [11]. The knowledge about students’ stress level ensures effective learning, improves quality of lectures and decreases stressful situations. Students are encouraged to change their attitude towards stress for better learning. Therefore this work aims to improve academic life for students by increasing their stress awareness.

Eustress and distress

As the physical and mental stress is increasing these days and with it its impact on people’s health, it is a research field with high potential to improve lives. As mentioned before, one’s attitude towards stress is important for one’s well-being. Stress in general can be distinguished in eustress (positive stress) and distress (negative stress). Eustress occurs in stressful situations that lead to positive emotions and is therefore beneficial for the outcome of stressful events. Distress evokes negative emotions and leads to anxiety and negative results. Eustress could apply to members of a student group who work on a project.
In this case the experienced stress leads to productivity since they are working on a concrete, positive goal. Distress could result from the ignorance of effective learning. Instead of asking other students or lecturers for help, the start of learning is being delayed in fear of failing, which leads to an even higher probability of failing.

The Project Stila

The Project Stila is a research project developed of the Teaching and Research Unit Programming and Modelling Languages at Ludwig-Maximilian University of Munich. Stila is an abbreviation for Stress Tracking in Learning Activities. The project visualizes computed stress, derived from pulse data collected from fitness trackers. Users are able to view their data, edit their activities and rate their stress level on a mobile application or on a browser dashboard. The goal of Project Stila is to increase the stress awareness among students and to distinguish between eustress and distress. Based on the data collected by Stila, academic institutions could improve stress situations for students, such as examinations, lectures and learning activities.

1.1.2 User-Centered Design

Researchers conduct stress studies by collecting and analyzing data and drawing conclusions from previous findings. To help people learn from these findings, the researchers’ conclusions have to be made accessible to and applicable for everyone. One approach includes the use of mobile and web applications, since mobile phones and computers are widely spread and a common technology nowadays. In the process of developing health applications user-centered design (UCD) plays an important role. UCD belongs to the field of human-computer interaction (HCI) and describes a repetitive design process with ultimate focus on the user. From the beginning of the design process the designer has to understand the user’s needs and goals. At any time during the process, the user is integrated. The main goal of UCD is to provide a positive user experience (UX). User experience is defined in ISO 9241-210: 2010 as a “person’s perception and responses resulting from the use and/or anticipated use of a product, system or service”.

A common approach to apply UCD principles to projects is called the UCD Process Model, containing following five steps:

- **Step 1: Key Data Collection**
  In a first step all key data important for the product that will be designed is collected. This includes for example the target group, technical specifications and constraints.

1https://www.iso.org/standard/52075.html
1.1. MOTIVATION

- **Step 2: User Research**
  User research is essential to know exactly what the user expects and to specify the user’s needs. Different methods depending on time, costs and context can be applied, e.g. “fly on the wall”, “personal inventory” [14, p.673].

- **Step 3: Data Analysis**
  All data collected up to this point is analyzed. Relevant information is filtered and interpreted to provide a solid basis for the next step of developing concepts.

- **Step 4: Design Concepts**
  Based on the data analysis a deliberate design concept is developed. It combines the user’s needs and requirements with previously identified benchmarks and possible constraints.

- **Step 5: Experience Prototypes**
  Prototyping is the crucial part in the development and improvement of a product. It provides early feedback at low cost from the user and allows further refinement.

The UCD Process is an iterative process. Depending on the size of the project step 2 to 5 can be repeated until the result has the desired outcome. In this work the UCD process will be used as a guideline to design a user interface.

1.1.3 Fundamentals of Data Visualization

The research field of data visualization is well-explored and contains a rich body of findings. This section provides an introduction to the perception of visual information and to the visualization of different data types.

**Perception of Visual Information**

Data visualization is the art of presenting information in an effective and efficient way to humans [8]. Human perception is a process that includes converting the 3-dimensional environment perceived by our eyes into a 2-dimensional image in our brain, which then interprets and computes the image back to 3-D. According to researchers the process of perception can be split into “preattentive processing” and “attentive processing” [7]. Preattentive processing “operates automatically and employs parallel processing” [7]. At this stage the receiver of information is unable to interfere in the process. During preattentive processing different features, so called “textons” [10] can be detected and distinguished from one another. Textons include color, crossing of line segments, etc. Subconscious perception is a powerful tool in the field of user interface design. Factors like color, position or grouping of objects each have different impacts on the first impression that an interface triggers.

**Data Types**

The term “data” comprises an abstract field of information. Therefore the specification of “data” helps to understand different features and reduces the complexity of data visualization.

Shneiderman [20] introduces seven abstract data types appearing in collections of items with attributes. They can be classified as follows:

- **1-dimensional data**: linear data types including textual documents, program source code, sequential lists, etc.
CHAPTER 1. INTRODUCTION

• **2-dimensional data**: map data with 2-dimensional layers e.g. geographic maps, newspaper layouts, etc.

• **3-dimensional data**: objects occurring in real world having volume e.g. molecules, animals, buildings etc.

• **temporal data**: time lines where items have a start and finish time e.g. medical records, historical presentations, etc.

• **Multi-dimensional data**: mostly relational and statistical databases where items with n attributes are represented applicable diagrams

• **Tree data**: hierarchical structures where every item except the root is linked to one parent item

• **Network data**: all data where items are linked to one or more items without compulsory hierarchical structure

Shneiderman further defines the “Visual Information Seeking Mantra”: **Overview first, zoom and filter, then details-on-demand**. To simplify the user’s search for information, an interface should show an overview over relevant data. If desired further information can be reached by zooming into the data of interest. This could be realized e.g. as a map where more data points get visible when zooming in or as a list of items that show additional information when selected. **Filters** can be used to select groups of items with one or more similar attributes. In a last step the user is able to refine the search by details-on-demand which leads to the display of a single item showing all details and information.

1.1.4 Conclusion

The field of human-computer interaction is growing and gaining importance as technical devices are used in almost all processes and actions nowadays. To integrate new technologies in our daily lives and to make them accessible and comprehensible for everyone is a main motivation for working on Stila, as well as making the university an even more attractive place to study.

1.2 Objectives

Stila’s current state includes a well-designed mobile application and a web portal, joining all functionalities in a basic design. **The main objective of this bachelor thesis is to redesign and implement the user interface (UI) of the Stila portal to increase stress awareness by improving the user experience.**

The tasks contain:

• Collection of key data and specification of target group

• Benchmarking and development of a concept

• First evaluation with prestudy

• Redesign of the Stila web portal according to user-centered design principles

• Implementation of responsive web design to provide access on all devices

• Deliberate color concept to support positive emotions
1.3. RELATED WORK

- **Final evaluation of implementation through final field study**

In a first step benchmarking is conducted, looking at different web portals from the fitness and health sphere. The results provide a basis to develop a deliberate design and layout concept. The main function of the layout is to support quick perception and orientation by giving an overview over main functionalities. If desired, more details can be shown. The handling should be easy, intuitive and self-explanatory. Feedback about the user interaction should be provided, as well as guidance through the information presented. Explanations of health terms could be one way to engage the user to interact with the interface. Another way could be to suggest lines of actions for the user’s daily life, to outline different aspects of stress. The color design should evoke positive emotions and help to identify with the application. Using the web portal should make the user feel good and motivate to interact with the interface. For being able to use the Stila portal on all devices, responsive web design will be implemented, using SASS and media queries. The conduction of a field study is the final step to evaluate the design and draw conclusions about its effect on users. Depending on the results deficits could be improved in future works.

### 1.3 Related Work

Morris et al. [16] conducted a study to evaluate a cell phone application for emotional self-awareness. Eight participants were asked to report their mood on a self-designed “Mood Map” several times a day during a period of one month. The participants lived in environments influenced by stressors (reasons for stress) like work tensions and personal relationships. If participants stated to be in a bad mood, therapeutic concepts were offered to them among others breathing exercises and answering questions to reflect about their current situation and emotions. The study showed that a mobile application could be used to improve self-awareness and self-reflection. This is especially interesting for further developments of the Stila app, e.g. providing useful suggestions to ease stressful situations.

Several studies cover the topic of informing students about their health via mobile applications. This process is supported by the common use of mobile phones and the development of health and fitness apps. Gowin et al. [5] were aiming at improving college students’ diets by using diet plans suggested by a mobile application. The test students responded overall positively to the app approving the insights they received from their health data.

Britt et al. [3] analyzed eHealth literacy among college students collecting information about health online. They identified online sources as very influential and suggested increasing knowledge about health issues via communication technologies. By that students can be influenced to change their personal behaviour in terms of a healthier lifestyle. The same findings provided another study by stating that students frequently searching for health information held a positive attitude towards a health-promoting lifestyle [24]. Both studies agree on the importance of knowledge about health and indicate the need for tools offering that knowledge.

However most of these studies aim at improving the students’ lifestyle by providing information about their health or by promoting physical exercise but few discuss the emotional state. A lot of research can also be found in the field of identifying stressors in academic life whereas to the best of the authors knowledge almost no studies collect real-life stress data from students.

The basis for this thesis provides Patrick Hagen’s master thesis “Eustress and distress detection from physiological data using supervised machine learning” [6]. He implemented
an algorithm to distinguish eustress from distress based on heart rate data and evaluated the algorithm during a field study with students. The evaluation proofed a maximum recognition accuracy for the detection of eustress and distress of 76.7% to 80.2% depending on the environment in which participants measured their stress level. Furthermore Hagen developed a visualization concept for computed stress data resulting in a first design of Stila web portal with focus on functionality. As a new approach, the subject of this thesis will be to redesign the current Stila web portal with focus on user experience and usability.
This thesis focuses on the redesign of the Stila portal. Different research stages were completed including benchmarking, paper prototyping and analyzing and combining the results to develop a new substantiated layout and design.

2.1 Benchmarking

Benchmarking is the process of finding best practices for the development of a product to gain knowledge, adopt techniques and accelerate the development [23].

In order to find out the best practices for designing web portals with a background in the fitness and health sector, this section covers benchmarking web portals of four different providers of fitness and health applications.

Health and fitness applications

A healthy lifestyle is becoming more and more important at present. Trends like food blogs, vegan diets and social fitness programs raise awareness for personal wellness. Even workplaces support employees to stay active and healthy and insurances offer incentives for reaching preset fitness goals. As a result the digital market for health and fitness grew enormously and developed a new sector called eHealth. The term eHealth includes all forms of digital support in the health sphere, e.g. administrative systems for hospitals, health care for elderly people or online workout programs for fitness enthusiasts [17]. Since body awareness plays an important role in everyday life and for each individual, more and more people use health and fitness applications. The introduction of wearables such as smart watches and fitness wristbands enabled the broad mass to track personal wellness.

To get an overview of how leading health and fitness application providers currently design their web presence, four popular web portals were examined and reviewed based on following factors:

- Functionalities: the analysis of functionalities highlights the focus of the web portal
• Color concept: the generation of color palettes shows which colors and combination of colors are currently popular in the health and fitness sector

• Usability and user interaction: examination of intuitive design and navigation

• Responsiveness: Google Chrome Developer Tools was used to imitate different devices and screen sizes and showed how the designers of the web portal solved this problem

2.1.1 Analysis of Four Web Portals: Fitbit, Google Fit, Garmin and Runtastic

Fitbit At the time of writing this thesis Fitbit is the leading fitness application in the US with more than 25 Million active users in 2017 [1, 9]. Users wear Fitbit fitness trackers to record heart rate, steps, activities, burned calories etc. The collected data are transferred to the user’s mobile phone via Bluetooth. By opening Fitbit mobile application or the web portal users are able to view their data.

The Fitbit start page (Figure 2.1) shows a dashboard with cards, giving an overview over all important data. The cards - comparable to notes on a clipboard - measure either one square of 320x320px or two or more squares combined to a rectangle. The user is able to choose which information will be shown on the cards from a list of features. Changing position of the cards is supported per drag and drop in order to arrange them according to personal preferences. The cards are white on a dark gray background directing the user’s attention on the content of the cards. When clicking on a card an overlay opens up showing more information with the option of changing to the Log View to get further details.

The page header consists of a navigation bar with four elements on the left side (Fitbit logo, Dashboard, Log and Community) and three elements on the right for viewing profile, messages and settings, indicated by significant icons. All important functionalities are accessible via the navigation bar.

The Fitbit web portal is responsive up to a width of 1280px when the number of columns on the dashboard decrease from four to three. Smaller screen sizes are not supported,

1https://www.fitbit.com/login
presumably because every user needs to install the Fitbit application on the mobile phone to synchronize data from the fitness trackers and therefore lacks the reason to access the web portal via mobile phone.

**Google Fit**  
Google Fit\(^2\) uses smartphone sensors and wearables to track users’ activities. It owes its popularity to its compatibility to many fitness applications. Google developed an own design style called Material Design.\(^3\) The guidelines are clearly defined by Google and every developer working on applications compatible with Google Fit should design the application according to these guidelines. The main idea behind Material Design is to create a user interface that applies to physical constraints. All elements and their attributes follow basic physical laws for light and shadow, weight, position, etc.

![Google Fit Dashboard](https://fit.google.com/)

Figure 2.2: GoogleFit Dashboard

The main page of GoogleFit implements a dashboard structure showing five cards and a calendar with logged activities. Every time the page is reloaded another color theme dominates the screen varying from dark red to dark blue, dark green and dark violet. GoogleFit is fully responsive. Depending on the screen width the cards are either arranged next to or below each other and the calendar shrinks and grows to fit the screen width. Only basic fitness tracking data is accessible on GoogleFit such as activities, heart rate, steps, distance etc. The dashboard is kept simple by providing basic functionalities for the average user who is not excessively doing sport and tracking personal training.

**Garmin**  
Garmin\(^5\) is one of the leading producers of fitness wearables and is supported by powerful partners from the fitness sector like Nike or MyFitnessPal\(^[13]\). The mobile application, which is also accessible via a web application, is called Garmin Connect\(^\text{TM}\) and registered more than 15 Million user accounts in 2016.

The login redirects to a dashboard with cards similar to Fitbit (Figure 2.3). The user is able to select which cards are shown and gets detailed information by clicking on the options icon on each card. A side menu on the left enables direct navigation to all parts of the portal. Garmin Connect\(^\text{TM}\) offers a broad range of functionalities e.g. health statistics including stress level, training plans, insights to aggregated data of Garmin users and

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\(^2\)[https://www.google.com/fit]
\(^3\)[https://material.io/]
\(^4\)[https://fit.google.com/]
\(^5\)[https://www.garmin.com/]
\(^[13]\)[https://connect.garmin.com/modern/]
CHAPTER 2. REDESIGN

Figure 2.3: Garmin Connect™ Dashboard

a Garmin community in addition to standard functionalities such as calendar, measuring heart rate, tracking activities and sleep patterns.

Overall Garmin focuses on fitness, not on health in general like GoogleFit, and targets active users with frequent sport activities. The design of the web portal equals the data-centered approach and is defined by straight lines and a minimum of coloring. White cards on a light gray background and a small number of light green, orange and blue colored highlights emphasize the focus on data. In contrast to the dashboard, the foldable side menu on the left side of the screen shows white letters on a dark gray background with white, blue, orange and green colored icons, evoking the association of a smart watch display. The side menu is closed by default showing a minimized version with an icon for each element instead of the written identifier and can be opened to its full size by clicking on an arrow symbol.

Garmin Connect™ is fully responsive. With decreasing screen width the cards on the dashboard are placed below each other reducing gradually to a single column. At a width of 670px the side menu vanishes and is replaced by a hamburger icon in the top left corner.

Runtastic With more than 130 Million users (as of March 2018) Runtastic⁶ belongs to the most used running and fitness applications worldwide [18]. Runtastic is compatible with Google Fit, Apple and Android Wearables and offers a range of additional applications supporting a healthy lifestyle.

The layout of the start page (Figure 2.4) is divided into three columns showing a side menu, personal statistics and latest news from the Runtastic community from left to right. The different parts are presented on white cards - comparable with a dashboard with cards - on a light gray background with colored highlights in green, blue and orange. Responsiveness is supported as the three columns switch to a single column, and the navigation bar and side menu collapse to a hamburger menu icon in the top left corner.

Runtastic focuses on sport as a social experience. The portal provides basic statistics of activities like GoogleFit but offers the possibility to share the data with a community. Users make their details accessible to other users which enables them to train in groups, share

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⁶https://www.runtastic.com
⁷https://www.runtastic.com
2.1. BENCHMARKING

2.1.2 Benchmarking Conclusion

The research of benchmarking in section 2.1.1 showed that all of the examined fitness and health web application developers use dashboards to display the user’s data. Following Shneiderman’s visualization mantra *Overview first, zoom and filter, then details-on-demand* (see Chapter 1.1.3) the dashboard provides an *overview*. Clicking either on dashboard elements or choosing from a navigation bar respectively side menu corresponds to *zoom and filter* and leads to aggregated information e.g. sleep data, activities, heart rate diagrams etc. More *details* can be reached by looking at single elements of information e.g. sleep patterns of one night, picking one activity, heart rate during this activity etc.

*Responsive design* is indispensable these days, hence most dashboards examined showed no loss of functionalities when used on smaller screens, except for Fitbit. The design of a dashboard with cards supports responsiveness as the cards can be arranged with a flexible or grid layout next to or below each other. Some elements changed due to compressing information, e.g. the navigation bar was replaced by a hamburger icon opening a side menu. The main goal and at the same time the main difficulty is to keep all functionalities implemented on larger screens and to present them in a comprehensible and well-arranged on small screens.

Each web portal had its own *color theme* with either dark colors as background and bright colors for information visualization or only bright colors. Overall colors were only used to highlight certain aspects and not to distract from the actual information. The prevalent colors were bright and lively, to communicate motion and positive emotions, *light blue* and *turquoise* being very popular.

All the examined web portals in section 2.1.1 collected their data the same way, namely via wearables or mobile phone. This leads to nearly identical basic *functionalities* that only differ in the way they are sorted and presented.
2.2 Paper Prototyping

In the field of user-experienced design paper prototyping is a well-established method to provide first evaluations of a design. Every screen, menu and other elements of the user interface are drawn on paper. The user who is testing the interface clicks on buttons by pointing on them with the finger. One member of the design team takes the role of a computer and changes the screens according to the user’s actions. Another team member observes the procedure and takes notes. The user is encouraged to describe his actions and his feelings. During this process weak points of the UI become quickly visible and can be improved on the spot. The low fidelity paper prototype gives the user the impression of a quick sketch with little effort, making it easier to criticize. Hence paper prototyping is an effective way to quickly get feedback about a design with low costs. [21]

2.2.1 Design Phase

The paper prototype used in this prestudy focused on testing the navigation through the web portal. Therefore the position of elements and the presentation of icons used to guide the user were important, not the design. As responsive web design is one of the main tasks of this thesis, two screen sizes were implemented as shown in Figures 2.5a and 2.5b. The large device matched a 4:3 12-inch display and the small device matched the size of a 5-inch mobile phone display.

![Figure 2.5: Layout draft of the Stila web portal for small and large sized screen devices](image)

The starting page was based upon the benchmarking results and was therefore designed like a dashboard. A navigation bar on the top allowed switching between three different pages. The **Dashboard** was the first page. Four tiles showed an overview over following data: weekly stress overview, daily stress level, aggregated stress level of activities and a calendar. The calendar could be adapted to show day, week or month. The monthly display showed seven days in a row with up to six columns and dots indicating activities. By clicking on a day the user reached the **Details page** for that day. Every tile led to more details if selected, except for the weekly stress overview.

The **Details page** presented more detailed information on different graphs. After selecting a certain time range (one day by default) the user could choose between displaying heart
rate, heart rate variability, computed stress and aggregated stress graphs (see Figure 2.7).

The Activities page showed a list of all activities of the user, ordered by date. The list included name, date, category and stress level of activities. A click on each activity redirected to the Details page with correspondent values for the activity.

The implementation on the small screen differed slightly from the larger one. To guarantee usability the functionality was reduced. The graphics on the starting page were placed below each other, not next to each other. The word “Login” on the login button was replaced by a login icon to find out its comprehensibility. All items of the navigation bar on top moved to a folding side menu indicated by a hamburger icon. The calendar tile was left out on the small screen and added to the side menu instead. Selecting the calendar in the menu led to a new page showing only the calendar as in Figure 2.6. The Details page showed results for a time range up to a week due to limited width and to maintain clarity.

![Figure 2.6: Design draft of the calendar for small sized screen devices](image)

![Figure 2.7: Design draft of the Detail page for large sized screen devices](image)

2.2.2 Procedure

Since the target group for the Stila portal are students, eight students aged between 18 and 24 participated in the prestudy. At the beginning of the prestudy no explanation was provided, only a short introduction to the goals of Stila. A conductor and a subject take part in a session. The conductor plays the role of the computer without explaining the user interface and observes the participants’ interaction. Three participants tested the navigation on a large device, five on a small device. The participants were asked to fulfill four tasks, including login and logout, as well as finding specific information e.g. their stress level from last Saturday. After completing the tasks the users filled out a questionnaire with five questions and rated the difficulty of tasks on a five-level Likert-type scale. The questionnaire is available in the appendix A.1.
2.2.3 Evaluation

During the presudy of testing the paper prototype two of the first four users tested the small and two the large device. It quickly became apparent that the navigation on the small device was more complicated than on the large one. Therefore five of the eight users tested the small device to work out its flaws.

One half felt neutral, the other half curious during completing their tasks. No negative emotions were reported. On the larger screen every participant quickly found the navigation elements and selectable buttons. Some participants didn’t understand the list of activities as a list of selectable elements. This problem can be solved by implementing an effect like shadow or change of color when hovering over it. For touch screens an icon like an eye can be shown, to indicate further details. On the large device logging in was easy for all users. In contrast the login icon on the small screen was perceived as confusing as users thought it looked like a logout icon (see Table 2.1).

<table>
<thead>
<tr>
<th>Definition</th>
<th>Small device</th>
<th>Large device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Login</td>
<td>Button</td>
<td>Login</td>
</tr>
<tr>
<td>Logout</td>
<td>Button</td>
<td>Logout</td>
</tr>
<tr>
<td>Clickable element</td>
<td>Box shadow</td>
<td>Navigation bar in header</td>
</tr>
<tr>
<td>Foldable menu (hamburger icon)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2.1: Icons used in paper prototype

Three out of five users were unsure if they were already logged in or not. Therefore the login icon won’t be used and instead will be replaced by a button labeled with Login. Logout was very easy for all users. The position of the Logout button in the navigation bar, as well as in the side menu was intuitive. Intentionally the first tile showing the weekly stress overview was not selectable. Users were confused and tried to click on specific days to get more details. Therefore all information depicted on the dashboard should be able to show more details on demand.

The users found the calendar in the side menu easily. Instead of completely omitting the calendar on the dashboard of small devices, as chosen on the paper prototype, a scrollable list of days during the selected time period could be implemented on the dashboard in addition to the calendar button in the side menu. One user noted that on the small screen day and week button in the detail view took a lot of space. A solution could be to use a dropdown menu to choose between different values.

Another user stated that too many clicks were required to reach the sought-after information and any content should be accessible with three clicks. This “Three-click-rule” is widely discussed in UX articles but overall not confirmed. Studies show that users accept a higher amount of clicks as long as they have an idea of how to get to their goal. Each click
has to be meaningful in terms of reaching information.

The prestudy helped to understand how users interact with the user interface. Especially the inspection of icons was important, to see if they were useful for representing information on a smaller screen.

### 2.3 Requirements

In order to provide a web portal on the one hand satisfying the user’s needs of intuitive handling and a comprehensible presentation of complex data and on the other hand collecting valuable data for further refinement of the algorithm computing the stress level, the redesign has to meet certain requirements analyzed in the next section.

#### 2.3.1 Requirements Derived From Prestudy

Evaluating the prestudy leads to following requirements concerning mainly user interaction:

- **User-centered design**: all aspects of UXD described in section 1.1.2 need to be fitted to the target group.

- **Intuitive Design**: each part of the interface should be self-explanatory for users. Especially elements that navigate to another page should be distinct without room for interpretation.

- **Responsive web design**: In order to realize responsive web design, some functionalities have to be adapted or left out for smaller screens the size of mobile displays. Graphs displaying values over time need a timeline with a range chosen according to the screen width.

- **“Keep it simple”**: All redundant elements should be removed and the pages designed with as many elements as necessary but as few as possible.

- **Explanation of keywords**: stress-specific keywords and medical terms require explanation to introduce the user to the topic, support comprehension and encourage using the web portal

- **Type-by-task-taxonomy**: Overview first, zoom and filter, details-on-demand, as described in chapter 1.1.3

#### 2.3.2 Functional Requirements

Stila portal provides following functionalities ordered by importance:

- **Data display**:
  - Heart rate (HR): line graph showing heart rate over time
  - Computed stress/ heart rate variability (HRV): line graph showing computed stress/ HRV over time
  - Aggregated activities: bar chart showing activities over time, colored according to feeling (positive, negative, neutral)
  - Aggregates activities: pie chart showing activities distributed by percentage according to feeling (positive, negative, neutral)
CHAPTER 2. REDESIGN

- HRV features: spider chart with distinct or aggregated pattern displaying eustress and distress over features during selected activities
- Login/logout with authentication process requiring username and password and allocating a user group
- Data confirmation: possibility to compare computed stress to user input, user is able to select time segments and confirm or refuse computed stress
- Calendar: displaying logged activities, adaptable time range (day, week, month)
- Data input: implemented for reasons of testing during development
- Admin view: users with administrator status are able to view aggregated data from one or more users and to change other users’ user group respectively their authorization
- Download HR data: users are able to download a CSV file containing their heart rate data during a chosen time range

Except for data input and download HR data the functionalities listed above are core functionalities of the Stila portal and therefore essential. Their implementation requires a plain design with easy handling to support a positive user experience.

2.4 Conception

This section covers a description of the redesign concept developed from analyzing and combining all requirements.

2.4.1 Color Concept

The color palette used in the first implementation consisted of a mix of highly saturated colors and less saturated shades of “traffic light” colors namely red, yellow and green and additionally black, as shown in figure 2.8.

![Color palette before redesign: “Sunny theme”](image)

As a first draft with focus on functionality this basic design is sufficient, however in terms of stress awareness leads to a wrong approach. Green and red are permanently used as opposites and by most users associated with positive and negative meaning. Thus mainly neutral color combinations should be used to support an unbiased perception towards stress.

Nonetheless the functionality of analyzing and presenting different stress levels suggests the use of colors to differentiate between phases of high and low, positive and negative stress. Therefore a color concept was chosen with focus on neutral and calming colors,
2.4. CONCEPTION

mainly different shades of blue and green.

As primary color a mix of blue and green was specified matching the Hexcode value of “#00A499”. The closest named color is Persian Green (Hexcode value of “#00A693”). The other colors were calculated by using the Tetrad scheme, which is a color scheme of four different hues comprised of two complementary color pairs [15]. The distance of the two pairs on the color wheel defines the harmony of the combination, the higher the more tension is produced up to a maximum value of 90 degrees. For the color theme of Stila shown in figure 2.9 a distance of 20 degrees was chosen to avoid tension and emphasize a calming effect. Complementary colors such as light and dark orange were added to navigation elements at rare intervals to serve as a minor visual contrast and support the structure of the layout.

Red, green and black as color representing eustress, distress and neutral feeling respectively rest were replaced by light green indicating eustress (Hexcode value of “#A9FF96”), a darker monochromatic version of the primary color indicating distress (Hexcode value of “#00665E”) and a brighter monochromatic version of the primary color indicating rest (Hexcode value of “#95CEFF”), shown in figure 2.10. Their meaning is no longer implied by color rather by shade and variation of the primary color.

Figure 2.9: Tetrad scheme: color wheel

Figure 2.10: New colors for stress representing eustress, rest, distress from left to right

Figure 2.11: Color palette after redesign: Stila theme

http://www.htmlcsscolor.com/hex/00A499

http://www.paletton.com
CHAPTER 2. REDESIGN

The background color equals a light gray to support the impression of a pin board displaying information on white paper notes with the intention of imitating a tool used in everyday life and thus removing the technical background of a desktop device. Furthermore a white margin on the left and right border of the screen implies scrolling to receive more information below the fold.

2.4.2 Logo

The Logo of the Stila web portal presented in figure 2.12 contains a white heart on a green-blue circle corresponding to the primary color. A white triangle on top of the heart creates the association of an apple. The elements heart and apple were chosen to place Stila in the health sector and trigger positive emotions. With its clear outlines and simple but significant shape the logo conveys the identity of Stila and can also be used without the text as the icon for the mobile application.

![Stila Logo](image)

Figure 2.12: Logo of the Stila web portal

2.4.3 Layout Concept

According to the findings from benchmarking discussed in chapter 2.1 the concept of a dashboard is widely used and an effective way of presenting data, hence this approach was adopted for the Stila web portal.

The existing structure of the web portal was revised and several changes were made as part of the new conception. The following paragraphs describe the functions and content of the views that will be implemented in the redesign:

**Login View** Gaining access to the Stila portal requires authentication and therefore a starting page containing a login will be implemented. Due to the concept of Stila where every user needs a Fitbit tracker and the Fitbit, as well as the Stila mobile application, mostly users who are already registered visit the Start page. Nonetheless an attractive look encourages the user to spend time exploring the web portal. However the previous Start page consisted of an empty page with one card in the center providing the login form. All elements of the navigation bar were visible without being logged in. As part of the redesign the login form will be replaced by a login button embedded in the navigation bar. The navigation bar placed in the header will be indicated but its elements will be invisible except for the Stila logo and the login button. The content of the main body will reveal interesting facts about the site such as charts showing the current average stress level of all users.

**Navigation Bar** The purpose of a navigation bar is to facilitate navigation through a website [4]. Therefore only the most important elements should be included and kept to a minimum number. The elements require significant names implying the function of their target to enhance comprehensibility.
2.4. CONCEPTION

Dashboard View  The term “dashboard” conveys the image of a tool for displaying information and thus will be used for the Home page of Stila web portal to give an overview of the user’s stress data. The page content will be allocated to several Material Design cards, each of them serving as a frame for one element. The elements include different charts to display the user’s daily, weekly and monthly stress data, as well as the calendar component and a list of the latest logged activities. The weekly stress chart could be especially interesting in terms of quickly visualizing the development of personal stress over a longer period of time. Every element should enable the user to get more detailed information by selecting the respective item e.g. by providing a tooltip or redirecting to the detail view. Figure 2.13 shows the design draft of the Dashboard view as used for the paper prototype.

Figure 2.13: A dashboard as start page after login

Detail View  The four core functionalities of the Detail view include:

- choosing a time range
- displaying computed stress
- user feedback about computed stress
- detailed charts displaying HR, HRV, stress features

When the Detail view is directly accessed via the navigation bar, the user can choose a time range with a datepicker. The computed stress chart will be displayed separate from the other charts since the chart is the most relevant for visualizing stress. To improve the algorithm computing stress the user is asked to give feedback about the accuracy of the computed stress levels. This function will be provided with a full description of how and why to give feedback to enhance its usability. Lastly more details can be displayed by selecting from a range of charts each with an explanation about its use, especially its connection to stress. For the moment there will be a HR, HRV and Feature chart but the implementation of grid layout will offer the possibility to extend the collection of charts in the future.
CHAPTER 2. REDESIGN

Activities View  This view is added to the existing views as the process of benchmarking proofed an overview of all logged activities to be valuable for users. A complete list will be implemented displaying the name, date and stress level of each activity. To enable user-friendly handling the list will be sortable ascending and descending either in chronological order or by name or feeling. Its main functionality is to provide a clearly arranged overview of activities to assist the user searching for specific information such as an activity during a specific time range.

Admin View  Previously divided up into Config and Admin page, these pages will be merged and their functionalities combined on a single page to enhance faster operation. Due to the handling of sensitive data four user groups with different authorizations verified via an authentication process during login exist. Depending on the user group the user gets access to the Admin view:

- Student: basic user, access to display of personal data
- Student+: students allowed to generate activities via the web portal for reasons of testing the system
- Lecturer: access to aggregated data of students visiting certain lectures, functionalities not completely implemented
- Admin: administrator, access to data of all users, authorized to change the users’ status i.e. the user group they belong to

The user groups described above will be maintained, however when the test stage of Stila web portal is finished the group Student+ will be deleted since it was only implemented for reasons of testing. Currently, resulting from a relatively small number of users, the role of Lecturers and Admins are equal therefore they both get access to the Admin view. In the future the roles will be more clearly distinguishable and their authorization may require further refinement.
Implementation

The web portal is based on a client-server model, where the client-server communication is run via a REST API. Since this work focuses on the client design the following chapter describes the implemented front-end technologies and the implementation of the concept developed in the previous chapter.

3.1 Technologies Used

The front-end of the Stila web portal is implemented with Angular2, an open-source platform for creating web applications. Angular2 is written in HTML and TypeScript in contrast to its predecessor AngularJS, which is based on JavaScript, and therefore allows clean coding and an effective use of interfaces and encapsulation. An Angular web application is built with reusable modules (NgModules) that can be combined to design complex applications. Furthermore it supports lazy-loading which decreases the loading time of a web page and improves the user experience by loading modules on demand. Although Angular5 is the currently available version of Angular it was not implemented due to its common popularity and stable version.

The style sheet language used for representing the content in the browser is called SASS (Syntactically Awesome Style Sheets), a style language that compiles into CSS. SASS allows the definition of variables which makes it more convenient to use and easier to adapt to changes in the design than plain CSS. Some HTML elements from the Angular Material package\(^1\) were implemented, such as the cards in the Dashboard view. The package provides Material Design components similar to Google’s Material Design specifications.

3.2 Page Layout

The following sections describe how the redesign was implemented on the different pages of Stila web portal.

\(^1\)https://material.angular.io/
3.2.1 Login View

Two major changes were conducted in the Login view. Firstly all navigation bar elements are invisible except for the Stila portal logo on the left and the login button on the right where users expect the login. As a result from evaluating the paper prototype in chapter 2.2.3 instead of using a login icon the word “Login” was combined with an icon showing the outline of a person indicating the existence of a personalized user profile. This description and the position of the button clarifies its meaning and expected behaviour. During the process of login the user is redirected to a Google login form and after the confirmation of credentials further redirected to the home page, the Dashboard view.

Secondly the empty starting page was replaced by a grid of cards aiming at inviting users to log in. Due to the limited number of current users and thus an insufficient amount of data the cards currently display mood pictures with scenes from student life. The pictures serve as placeholders for charts that can be shown on the cards when Stila collects a larger amount of user data, e.g. an overview of the current average stress level of all users or the latest most stressful activities. Figure 3.1 shows the redesigned Login view.

![Figure 3.1: Login view after redesign](image)

3.2.2 Header

The page header is the first element visible to users and needs to carry the identity of the website. Its design should represent the identity of the page without distracting the user from the content.

**Background picture** Instead of leaving a blank header background or replacing it with a royalty free stock photo, a vector graphic specific to Stila was created. As shown in figure 3.2 the graphic consists of primitive shapes e.g. rectangles and circles, adding up to elements from academic life as well as nature and health in earthly colors, respectively variations of the primary color. The design is intentionally simple so that the user immediately perceives the image without having to process details. Furthermore the design aims
3.2. PAGE LAYOUT

at conveying positive feelings and a healthy lifestyle.

![Figure 3.2: Vector graphic for header background](image_url)

**Navigation bar** The first draft of the Stila portal in figure 3.3 included five link elements in the navigation bar redirecting to different pages, as well as a logout button.

<table>
<thead>
<tr>
<th>Stila Portal</th>
<th>Home</th>
<th>Input</th>
<th>Admin</th>
<th>Config</th>
<th>About</th>
<th>Logout</th>
</tr>
</thead>
</table>

![Figure 3.3: Navigation bar before redesign](image_url)

During the process of redesign the number of links in the navigation bar was reduced to three for users belonging to the user group students and to four for higher level users namely lecturers and admins. The insignificant link description *Home* was renamed to *Dashboard*, which immediately tells the user to expect access to personal data. So far the *Detail view* was only accessible via the calendar on the *Home* page and no overview of activities existed, therefore the links *Details* and *Activities* were newly created, as shown in figure 3.4. If correctly authenticated the link *Admin* for higher level users redirects to a page with all functionalities from *Config* and *Admin* merged. The *Input* page served as platform for testing different functionalities during software development with no actual function for the user, hence it was removed. The information from the link *About* containing the credits of Stila web portal was switched to the footer and the link deleted, since it provided no useful elements at all.

### 3.2.3 Dashboard View

To get an overview of the user’s general stress level the first card contains a line graph showing the weekly stress level, precisely the course of the stress level from the last seven days. The second card contains a list of the latest activities and information about the title, date and stress level indicated by color, as users are assumed to be mostly interested in their stress levels during their latest activities. Hence the activity list provides a shortcut to the points of interest and avoids additionally visiting the *Activity view*. Clicking on one activity redirects to the *Detail view* and the equivalent time slot. Another card shows a gauge chart indicating the user’s stress level during the current day. The gauge chart quickly presents data in a way easy to understand and supports the experience of a holistic overview. These first three elements are depicted in figure 3.5. The fourth card includes the calendar where each activity is depicted and redirects to the *Detail view* if selected. Following the calendar two charts show aggregated activities as a bar chart and aggregated feelings as a pie chart.
These charts display monthly data, hence extend the daily and weekly overview with additional monthly numbers.

All cards are white on a light grey background with an additional shadow when hovering over them producing an effect of increasing distance between the card and the background. Orange info buttons are placed in the top right corner of each card providing a tooltip with information about the content of the card. The tooltips assist the user with understanding and interacting with the charts.

Figure 3.5: The first three elements of the dashboard after redesign

3.2.4 Detail View

On the top of the page three info boxes (see fig. 3.6) explain the most important features, namely choosing a time range, displaying detailed charts and giving user feedback about computed stress.

The Detail view contains a datepicker to select the time range during which the user requests details. When navigating to the Detail view via the navigation bar the default time range equals the current day, when redirected from selecting an activity the respective time will be shown. All charts on the page are automatically updated if the user changes the time range. As displaying computed stress is the main feature on the page the computed stress line graph was implemented second, separate from the other detailed charts and instead
3.2. PAGE LAYOUT

Figure 3.6: Boxes providing information about the features of the respective page

close to the datepicker to enable fast modification of the time selection.

The next page section contains the feedback function in the form of a timeline (see fig. 3.7). The timeline consists of two streams divided in time segments, one depicting the user’s logged activities, the other one below showing the computed stress indicated by color. One timeline feature allows going forward and backward in time and choosing the span of time from day, week or month. To give feedback about whether or not the computed stress complies with their own perception of stress the user selects time segments per click and drag and chooses from two buttons to send feedback, previously labeled Confirm and Refuse. Without explanation the user could not know how to handle the buttons or what their effect was. Hence they were replaced by the statements “Yes, I felt this way” and “No, that’s not true” in addition to thumbs-up and thumbs-down icons to visualize their meaning. A help icon explains their functions and encourages the user to use them and by that improve the computed stress accuracy.

Figure 3.7: Timeline integrated in feedback function

The feedback function is followed by a list of cards, each of them containing an icon and a button displaying the name of a chart (see fig. 3.8). When the user selects a chart it is opened up below and closed on a second click, the button changing color to indicate an active or inactive state. The list of charts is implemented with grid layout and is therefore extensible in case of adding charts in the future. Currently three buttons are displayed to select from charts showing heart rate, heart rate variability and a spider chart for aggregated stress levels and HRV features.

3.2.5 Activities View

The Activities view shows a complete list of the user’s logged activities, as displayed in figure 3.9. Name, date and stress level of each activity are provided, further details are accessible by clicking on an activity which redirects to the Detail view. The possibility of more information is indicated by a shadow when hovering with the mouse pointer over an activity. The list can be sorted descending and ascending by name, date and the three
stress levels positive, negative and neutral. A colored dot indicates the stress level, using the same colors for eustress, distress and neutral feeling as in the Dashboard view to support a consistent color design.

![Figure 3.8: Buttons to choose detailed charts from stress levels positive, negative and neutral. A colored dot indicates the stress level, using the same colors for eustress, distress and neutral feeling as in the Dashboard view to support a consistent color design.](image1)

![Figure 3.9: Sortable list of activities](image2)

### 3.2.6 Admin View

Admin view merges the functionalities of the previous Config and Admin page. Users authenticated as lecturer are able to view anonymized aggregated data from students attending their courses. Users holding administrator rights are additionally authorized to change other users’ status. The list of users adapts the new color concept, as well as an easier handling due to an increased size of the buttons (see fig. 3.10). Info boxes at the top of the page explain the two main functionalities of the Admin view and introduce the user to the content and use of the page.

![Figure 3.10: List of users showing authorization](image3)
3.3 Visualizing Data

For visualizing data the Highcharts\(^2\) library written in JavaScript is included. It provides a wide range of different chart types from which to choose and a flexible presentation of data adaptable to the developer’s needs. To include Highcharts in Angular2 the angular2-highcharts\(^3\) module was needed as a wrapper, which reduces some of its functionalities and might be the reason for problems with responsiveness.

The time and datepickers as well as the calender implemented in Dashboard and Detail view are imported from the open source library PrimeNG\(^4\) which is based on Fullcalendar\(^5\) and provides a large range of UI elements for Angular. Fullcalendar proved especially useful for displaying events on a timeline as realized in the Detail view.

3.3.1 Used Charts

Following paragraphs provide a short descriptions of the charts used in Stila web portal. The dashboard implements four charts using Highcharts library, the Detail view another four charts from Highcharts and the timeline from FullCalendar.

**Weekly Stress Chart**  The *weekly stress chart* shown in figure 3.11 represents a line graph displaying three data points per day connected by a spline. It serves as an overview for the user, immediately visible and comprehensible.

![Weekly Stress Chart](image)

*Figure 3.11: Weekly stress chart on dashboard*

**Daily Stress Chart**  The *daily stress chart* in figure 3.15 illustrates the user’s average stress level on the current day, hence it only visualizes one data point expressed as a percentage. A gauge chart was chosen because it carries the impression of a variable that changes with every additional data set and not the impression of a fixed value.

\(^2\)https://www.highcharts.com/
\(^3\)https://www.npmjs.com/package/angular2-highcharts
\(^4\)http://www.primefaces.org/primeng
\(^5\)https://fullcalendar.io/
CHAPTER 3. IMPLEMENTATION

Aggregated Activities and Aggregated Feelings  The two charts aggregated feelings and aggregated activities, as shown in figures 3.12 and 3.13, are implemented as a pie chart and a bar chart giving an overview over monthly data. These types of charts are well-suited to visualize the proportions of elements of interest on one glance [22]. The month displayed in the charts can be changed by switching forward or backward via arrow buttons.

Heart Rate Chart  The heart rate is illustrated by a line graph. Its x-axis represents time values and adapts automatically to the time range specified by the datepicker of the Detail view. The y-axis shows the heart rate in beats per minute (bpm). An additional Navigator[2] allows zooming in and out on parts of the data as well as horizontal scrolling. For better orientation the time segments during which eustress, distress or rest was computed are labeled with the corresponding colors.

Heart Rate Variability and Computed Stress Chart  HRV and CS are displayed in a similar manner as the heart rate in figure 3.14. They differ from the HR chart in the label of the y-axis, showing HRV respectively CS in percent and a dashed yellow line indicates the stress threshold.

Feature Chart  The chart in figure 3.16 displays several HRV features on a spider chart. It aims at simplifying the detection of distinctive patterns in the combination of eustress and distress and therefore requires detailed explanation in order to be comprehensible for users. Either each eustress segment, distress segment and rest segment during a selected time range is depicted, or the time segments for eustress, distress and rest are aggregated
3.4. RESPONSIVE LAYOUT

Figure 3.15: Daily average stress

Figure 3.16: HRV aggregated feature chart

and their combination is depicted in the respective colors of light green, dark green and light blue, as described in chapter 2.4.1.

3.3.2 Limitations

The design of the dashboard where all components are encapsulated in cards from Angular Material Design caused conflicts with the responsiveness of the charts. Due to Angular’s lazy loading the charts were loaded earlier than the card component and therefore failed to fit the card width when resized. This problem was not completely solved but avoided by setting the CSS attribute overview of the cards to auto resulting in a horizontal scroll bar for each card in case the width of the content exceeds the width of the card. By that even on small screens every part of information is accessible with a minor trade-off in usability. An upgrade of Angular2 providing an improved compatibility with Highcharts might help to solve this problem.

3.4 Responsive Layout

Responsiveness is a common standard on the Internet as users access websites from devices with a wide range of different screen sizes. In this work responsive web design is implemented on all pages via media queries as part of the CSS3 specification. Media queries enable the developer to define different CSS attributes depending on the type of device and on the screen size. As the pages of Stila web portal contain mainly unequal elements no standardized grid layout could be implemented. Instead individual media queries depending on the content elements in relation to common screen sizes were used to create an easily operated UI, as implied in figure 3.17. Elements of interest were hereby:

- **Navigation bar**: Its elements are rearranged to three links on two lines respectively two links on three lines with decreasing screen width. Replacing the navigation bar with a side menu was abandoned after the paper prototype was evaluated to reduce the number of clicks.

- **Elements of the Dashboard view**: As long as the card content allows it the cards shrink down to a certain width and then realign themselves below each other.

- **Info boxes**: The font size is scaled down and to a screen width of 500px only significant icons without text are shown so as not to hide all functionalities from the view by focusing on the info boxes.
• **Content of Login view:** The cards are arranged in a grid layout, the number of columns depending on the screen width.

• **Charts:** As mentioned in section 3.3.2 the charts keep their default size whereas the cards resize dynamically and provide horizontal scrolling to view all information.

Additionally minor breakpoints were applied to adjust paddings and margins. Buttons kept their minimum width and height of 40px, the recommended minimum size for buttons to ensure user-friendly operation on touchscreens according to Google Developers [12].

![Dashboard view displayed on different screen sizes](http://ami.responsivedesign.is)

Figure 3.17: *Dashboard view displayed on different screen sizes* \(^6\)

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\(^6\)This figure is generated by the tools available at http://ami.responsiveisdesign.is
CHAPTER 4

Evaluation

In order to evaluate the redesign of the Stila web portal a field study with a subsequent questionnaire was conducted. This method, similar to the evaluation of the paper prototype described in chapter 2.2, aims at identifying the flaws of the redesign and measuring the user experience.

The categories of interest regarding the field study evaluation included the navigation through the website by rating the ease of performing the most important tasks. Furthermore, the comprehensibility of the design was examined, especially the display of different kinds of charts belonging to the field of data visualization. The third category of interest contained the users' personal attitude towards stress and aimed at evaluating if and to which extent Stila web portal helps users to increase their stress awareness.

4.1 Field Study Procedure

A group of students enrolled in a Master program of Computer Science took part in the field study. The participants were provided with a Fitbit fitness wristband to track their heart rate over a period of eight days. Using the Stila mobile application the participants recorded and labeled their activities with negative, neutral or positive stress labels. They were asked to visit Stila web portal on a daily basis to explore and test all functionalities on different devices with differing screen size. At the end of the tracking period the students filled out a questionnaire attached in appendix B.1 containing 14 questions such as “How helpful were the charts to understand your stress level?” or “Does Stila web portal help you to perceive your stress?”. A five-point Likert-type scale, where the steps from 1 to 5 all have the same distance and 3 equals a neutral value, and mainly close-ended questions were used to keep the user motivated and to produce comparable results from all participants. At the end of the questionnaire participants were able to write a short comment including their personal opinion about the portal.
CHAPTER 4. EVALUATION

4.2 Results

Nine participants including seven students aged 22 to 32, one postgraduate and one lecturer filled out the questionnaire. One user, presumably the lecturer, answered the questions without having visited Stila web portal and therefore his answers were neglected as part of this evaluation.

To know if the participants were familiar with web portals visualizing data, they were asked whether they had prior experience with fitness trackers, especially with one of the companies examined during the benchmarking process. Five participants had previously used fitness trackers and the corresponding web portals from Fitbit, GoogleFit, Huawei Health and Xiaomi. Overall their answers regarding the usability of Stila portal did not significantly differ from the users’ answers without prior experience, indicating that Stila portal is likewise operable for users with different levels of knowledge about fitness applications.

Navigation Two questions regarded the navigation through the website. The participants were asked, how long it took them in average to reach the information they were looking for and answer on a five-point Likert-type scale from 1 = not long to 5 = too long. All results fell into a range from 1 to 3 showing that all users were able to navigate through the website in an acceptable time span.

![Figure 4.1: Rating navigation](Image)

Secondly the user rated how easy it was to carry out the most important tasks, including login, logout, getting information about the week, finding an overview of activities, finding details for a specific activity and today’s stress level and giving feedback about stress level. The stacked aggregated bar chart in figure 4.1 shows that all main tasks were easy to fulfill except for giving feedback about stress level, an important but complex feature of Stila web portal. This result may follow from a lack of information about why the users are asked to give feedback and how they can accomplish the task. If more detailed explanations about giving feedback prove insufficient in the future, another visualization of the task needs to be chosen.
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Comprehensibility of charts  To evaluate the data visualization in Detail view and Dashboard view, namely the overview charts showing weekly stress, daily stress, aggregated activities, aggregated feelings as well as the more detailed CS chart, HR chart, HRV chart and Feature chart and the timeline, the users were asked to rate each on a scale from 1 = very easy to understand to 5 = very difficult to understand with 3 = okay being the neutral element. According to the results displayed in figure 4.2 the weekly stress chart, a simple line graph showing the user’s stress level during the last seven days, was the easiest to interpret. Since this chart is the first one the user comes across after logging into Stila portal, its comprehensibility is a major aspect regarding the attractiveness of the dashboard.

Although in average none of the charts was difficult to understand the Feature chart was probably the most difficult chart in comparison to the others as no user rated 1 and one user rated 5. This may result from a lack of information about the axis and the content they represent. A more detailed explanation seems necessary to clarify the meaning of the chart for users new to the field of stress research.

Figure 4.2: Interpreting charts

Personal attitude towards stress and role of Stila  Being asked whether they often feel stressed, half of the participants answered Yes, the other half No. Regardless of the amount of stress they experience in everyday life, 6 out of 6 users named family and friends to be a source of stress followed by university stated by 5 out of 6 users. This result underlines project Stila’s goal to decrease stress in academic life and legitimizes its existence.

Figure 4.3 visualizes how helpful the charts were regarding the users’ stress perception. The darker the red areas the more helpful were the charts. As the stacked bars are predominantly filled dark red the task of displaying data relevant for users was successfully

1http://shiny.chemgrid.org/boxplotr/
Users’ suggestions

The informal comment section at the end of the questionnaire provided the possibility to leave suggestions for further development of Stila web portal. Four participants used this opportunity and left comments, the first one regarding the **Detail view**.

‘It is somehow confusing, which type of chart is opening or is it opening or where is it opening.’

When choosing one of the buttons to display HR, HRV, or Feature chart no hint is provided as to where the chart is opened. In most cases the chart is shown below the fold in an area only visible when the user scrolls down. To avoid confusion and support better usability either an arrow pointing down could be added or the view could automatically move down to the chart position.

Another user asked for more ‘information about the meaning of the charts [...]. The actual tooltips don’t provide any good information’. However improving the chart descriptions very likely leads to a longer text exceeding the readability of tooltips. Therefore the tooltips could be replaced by overlays activated when clicking on an info button.

Two users mentioned the same issue, claiming the colors were not self-explanatory and asking for a legend to clarify the meaning of colors:

‘A short legend for the used colors would be nice.’

‘A hint indicating what each color means would be great.’

As part of the redesign the color legends were omitted with the objective of finding out whether the new color concept would prove self-explanatory. The evaluation disproved this assumption, hence a color legend will be added to the **Detail view** connecting the colors to **eustress**, **distress** and **neutral** respectively.
4.3 Summary

The redesign mainly aimed at fostering stress awareness by making the handling of Stila portal more comfortable and enjoyable as well as evoking positive feelings. Furthermore the charts intend to give comprehensible information about the user’s stress level. The following user’s comment indicates that this goal was attained:

‘I really like the look and feel of the portal and the graphs that you are using [...].’

The most significant finding was that the use of Stila portal helped a majority of users with their perception of stress. No participant stated a negative user experience during the use of the portal or claimed that it was useless. Therefore the redesign of Stila web portal can be seen as largely successful.
5.1 Summary and Discussion

This work aimed at increasing student’s stress awareness to remove pressure and improve their academic life. To meet this goal implementation and evaluation focused on a user-centered approach from the field of user experience. Users from the target group were included in all design stages to evaluate the design as early as possible. The first evaluation with paper prototyping provided valuable information such as the use of icons or the appearance of navigation elements and was implemented in the second design. Although minor deficits e.g. missing color legends were identified, evaluation in the course of a field study approved the overall design and its purpose to provide information about stress.

The approach to separate the development of the mobile application and the web portal may first seem unusual. On second glance however this procedure illustrates the differences between both tools. The mobile application primarily serves the purpose to collect data from user input. Its design aims at attracting users to interact with it and frequently spend time using it. Visualization of data however mainly takes place at the web portal. Stress levels are best visualized by displaying charts with sufficiently large data sets over a longer period of time. This constraint is well supported by the web portal due to less restrictions of the screen size and content. The web portal provides a platform containing enough space for giving an overview as well as showing detailed information.

The realization of this work faced some limitations such as the use of Angular2 instead of more recent versions of Angular. Angular2 might be very stable, however Angular5 provides better possibilities to implement Material Design and includes a larger amount of UI elements.

The use of certain colors might also require further discussion. Especially the effect of colors is hard to predict and although there are many studies about colors and their effect on people’s moods. Still, there is no concept that works globally due to cultural diversities. A colorful example for this problem is the phrase ‘green with envy’ which equals the German expression ‘gelb vor Neid’ translated to ‘yellow with envy’ instead of green.
5.2 Future Work

Adapting the system to the findings from the field study

In the near future the findings from the field study should be implemented correlating with the users’ suggestions. These include:

- display of color legend
- further development of chart descriptions and information respectively explanation of stress features
- improving feedback functionality

Further development of the feedback function

The evaluation from the field study showed that not all users knew how to use the feedback function. Its implementation faces a number of challenges. First of all, users need to understand its intention and the reason why it is considered important. Therefore it requires detailed explanation and an attractive design that invites users to commit feedback frequently. Furthermore three different types of values have to be visualized including a specific time range, activities labeled with the user’s stress level during the respective period of time and additionally the computed stress levels. This implementation could be subject for further research in the field of data visualization plus the psychological components of how to ask the user for help.

Increasing the number of users and the data collected

There is room for discussion whether the amount of participants in the field study was sufficient. The results of the field study strongly depended on the test persons’ participation and out of ten users one did not fill out the questionnaire. However every participant belonged to the target group and provided insight to opinions that are valuable for a first evaluation and can be seen as exemplary for the target group. In the future the redesign should be tested with more users to see if it withstands a larger group of individuals.
Bibliography


APPENDIX A

Prestudy

A.1 Questionnaire
Prestudy with Paper Prototyping
Anna Hubert, bachelor thesis

Information about participant:
Age: _______ Gender: _______ Occupation: _______________

Introduction:
Project Stila is a research project that visualizes computed stress, derived from pulse data collected from fitness trackers. Users are able to view their personal stress data on a mobile application or on a web portal.
The paper prototype shows an early mockup of the web portal, one on a larger and one on a smaller device. The results of the prestudy are important to improve navigation through the web portal.

Screen size: large/small
Your role: student/lecturer
Your tasks:
1. Login
2. View your students stress level during your last lecture on Monday
3. View your heart rate from last Saturday.
4. View your latest activity and your stress level during its length.
5. View your weekly stress level.
6. Logout

Please rate the following points:

<table>
<thead>
<tr>
<th></th>
<th>very easy</th>
<th>easy</th>
<th>okay</th>
<th>difficult</th>
<th>very difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fulfilling task 1</td>
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<td></td>
<td></td>
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<tr>
<td>Fulfilling task 3</td>
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<td>Fulfilling task 4</td>
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<tr>
<td>Fulfilling task 5</td>
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<tr>
<td>Fulfilling task 6</td>
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</tr>
<tr>
<td>Finding the menu/navigation bar</td>
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<tr>
<td>Finding the logout button</td>
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<tr>
<td>Understanding the Dashboard</td>
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</tbody>
</table>

How long did it take to complete your tasks all together? ______________

Did it feel too long? O Yes O No
If yes, why? __________________________________________________________

How did you feel during your tasks?
O bored   O stressed   O annoyed   O neutral   O curious   O happy
Other: ________________________________________________________________
A.2 Paper Prototype Layout for Small Devices

Include pictures of paper prototype:

Figure A.1: Small Device: Layout
Figure A.2: Small Device: Start page
Figure A.3: Small Device: Login
A.3 Paper Prototype Layout for Large Devices
Figure A.7: Small Device: Details
Figure A.8: Small Device: Activities
Figure A.9: Large Device: Layout

Figure A.10: Large Device: Start page
A.3. PAPER PROTOTYPE LAYOUT FOR LARGE DEVICES

Figure A.11: Large Device: Dashboard

Figure A.12: Large Device: Details
Figure A.13: Large Device: Activities
APPENDIX B

Field study

B.1 Questionnaire
Feedback for Stila web portal

Thank you for supporting my Bachelor's thesis and participating in the field study to evaluate the design and features of Stila web portal.

Please take your time to fill out the questionnaire below, it will only take around 5 minutes.

If you encounter any issues, please feel free to contact me: a.hubert@campus.lmu.de

* Erforderlich

1. How old are you? *

2. In which Bachelor or Master program are you enrolled? (e.g. Informatics/Media informatics etc.) *

3. Was this the first time you used a fitness tracker? *
   - Yes
   - No

4. If no, which provider did you use before?

   - Garmin
   - Runtastic
   - Apple Health
   - Google Fit
   - Fitbit
   - Sonstiges:

5. How often did you visit Stila web portal in the period from 07.05.18 - 15.05.18 *

   - Once
   - 2-4 times
   - 4-7 times
   - More than 7 times
   - Sonstiges:
6. How long did it take in average to reach the information you were looking for? *

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<tr>
<td>Not long</td>
<td></td>
<td></td>
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<td></td>
<td>Too long</td>
</tr>
</tbody>
</table>

7. How was it for you to carry out the following tasks? *

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<thead>
<tr>
<th>Task</th>
<th>very easy</th>
<th>easy</th>
<th>okay</th>
<th>difficult</th>
<th>very difficult</th>
<th>not used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Login</td>
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<tr>
<td>Logout</td>
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<tr>
<td>Get information about the week</td>
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<tr>
<td>Finding the overview of activities</td>
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<tr>
<td>Finding details for a specific activity</td>
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<tr>
<td>Finding details for today's stress level</td>
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<tr>
<td>Giving feedback about stress level</td>
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</tbody>
</table>

8. Was it clear for you to interpret the data visualization? (on a scale from 1 to 5) *
1 = easy to understand, 5 = hard to understand

<table>
<thead>
<tr>
<th>Visualization</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly stress chart (Dashboard menu)</td>
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<tr>
<td>Daily stress chart (Dashboard menu)</td>
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<tr>
<td>Computed stress chart (Details menu)</td>
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<tr>
<td>Heart rate chart (Details menu)</td>
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<tr>
<td>Heart rate variability chart (Details menu)</td>
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<tr>
<td>Feature chart (Details menu)</td>
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<tr>
<td>Timeline with computed stress segments (Details menu)</td>
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</tbody>
</table>
9. How helpful were the charts to understand your stress level? (on a scale from 1 to 5) *
   1 = least helpful, 5 = very helpful

<table>
<thead>
<tr>
<th>Weekly stress chart (Dashboard menu)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>don't know</th>
</tr>
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<tbody>
<tr>
<td>Daily stress chart (Dashboard menu)</td>
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10. Do you often feel stressed? *

   ○ No
   ○ Yes

11. If yes, which source causes stress in your life?

   ○ University
   ○ Job
   ○ Family & friends
   ○ I don't know
   ○ I don't want to tell
   ○ Sonstiges:

12. Do you think stress is bad for your life? *

   ○ Yes
   ○ No
   ○ Depends on the situation
   ○ I'm not sure

13. Does Stila web portal help you to perceive your stress? *

   ○ Yes
   ○ No
   ○ Don't know
   ○ Sonstiges:
14. Do you have any comments relating to Stila web portal?