Investigating motivational and usability issues of mHealth wellness apps for peoples to ensure satisfaction

An exploratory study

Kalimullah Khan

Faculty of Computing
Blekinge Institute of Technology
SE-371 79 Karlskrona Sweden
This thesis is submitted to the Faculty of Computing at Blekinge Institute of Technology in partial fulfillment of the requirements for the degree of Master of Science in Computer Science. The thesis is equivalent to 20 weeks of full time studies.

Contact Information:
Author(s): Kalimullah khan
E-mail: kakh08@student.bth.se

University advisor:
Sara Erikson
DIKR Department of Creative Technologies
Faculty of Computing
Blekinge Institute of Technology
SE-371 79 Karlskrona, Sweden
Internet : www.bth.se
Phone : +46 455 38 50 00
Fax : +46 455 38 50 57
ABSTRACT

Context: In recent years, the evolution of information and communication technology has led a considerable change in the field of health care. Due to their recently created technologies and improvements made in smartphones, tablets and applications developed have led to a branch in eHealth called mHealth. The purpose of mHealth applications is to make the lives of peoples easier by controlling and monitoring several aspects of their day to day activities and by providing services in the fields of healthcare, nutrition and daily activities (e.g. physical activity/exercise) irrespective of place.

Objectives: For managing one’s own fitness and health, usability issues and motivational aspects related to the interaction design of an mHealth application plays a pivotal role, if not addressed properly. The objective is to explore how these issues can be measured and evaluated for mHealth wellness applications for a healthy lifestyle. The results of the project are expected to support developers in understanding the needs and expectations of users while using these applications and continue use over time.

Methods: In this research, an investigating study of a specific mHealth application, which supports a physical activity is conducted and main focus is on the interface of the application used by the trainers. For this purpose, the author has conducted a literature review and an exploratory study with an already developed app (Activio) used by trainers and trainees in gym and fitness centers. Usability evaluation for that application was conducted by using think aloud method. The main source for evaluating the usability of the mobile application is users and their interaction with the application. Its worth to mention that, in this thesis, users were categorized into trainers and students and their perspectives on usability were inspected and compared. Interviews are conducted for validation of test results and questionnaires are distributed to get feedback from the participants.

Results: The results showed some usability problems but overall satisfaction was shown with application. Functionality and services provided by the mHealth wellness application’s interface was evaluated by using think-aloud technique a common usability testing method. Furthermore, recommendations for improvement of the mHealth wellness application regarding usability aspects have been gathered during the study and are conferred in the thesis.

Conclusions: The author provided suggestions based on test results and identified usability issues for the improvement of mHealth wellness application.

Keywords: mHealth, usability, activio, wellness, motivation.
ACKNOWLEDGEMENT

I would like to extend my deepest gratitude to my supervisor, Professor Sara Eriksén for her valuable feedback and experience. Without her support I would have never been succeeded in achieving this milestone. She has not only given feedback but also supported me and motivated me for the work.

I would also like to thank all those fellow students, trainers and developers from BTH, Lok and motion fitness centre and activio AB company who participated in this study. It would have not been possible without their active participation and feedback.

I would also like to thank Thomas Heiderup the boss of lok&Motion Gym, Karlskrona for providing me the Activio app and the necessary support whenever i needed.

A special word of appreciation for my wife Dr Isma Rafiq Khan and my little angels (Mariam and Shahbaz Khan) for being the reason of my achievements here at Blekinge Institute of Technology.
List of Tables

Table 1 Usability quality (components) (Source: Novak (2014)) [34] ......................... 21
Table 2 Activity definition ........................................................................................... 26
Table 3 Summary of task duration (Trainers) ............................................................. 28
Table 4 Summary of task duration (Students) ............................................................. 29
Table 5 Summary of observations .............................................................................. 29
Table 6 Summary of usability evaluation attributes (Activio) app .............................. 31
Table 7: Overview of the interviews ......................................................................... 36
List of Figures

Figure 1: Overview of the Research Design ................................................................. 18
Figure 2 Comparison of time taken by trainers and students ................................. 30
Figure 3 Total mean percentage of overall user response on questionnaire (Trainers and Students) ........................................................................................................ 32
Figure 4 Mean value of learnability between trainers and students ....................... 33
Figure 5 Mean value of Efficiency between trainers and students .......................... 34
Figure 6 Mean value of Memorability between trainers and students.................... 34
Figure 7 Mean value of Error rate between trainers and students ......................... 35
Figure 8 Mean value of Satisfaction between trainers and students ........................ 35
# Table of Contents

Contents

**Abstract** ........................................................................................................................................................... 1

**Table of Contents** ................................................................................................................................................. V

**Chapter 1: Introduction** ........................................................................................................................................ 8

1.1 Background and Motivation ............................................................................................................................ 8
1.2 Related Work ...................................................................................................................................................... 9
1.3 Structure of the Thesis .................................................................................................................................... 11

**Chapter 2: Problem Definition** ...................................................................................................................... 13

2.1 Problem Definition ......................................................................................................................................... 13
2.2 Mobile Health .................................................................................................................................................. 14
2.3 Mobile Application (Wellness) Activio ........................................................................................................... 14
2.4 Aims and Objectives ..................................................................................................................................... 15
2.5 Research Questions ....................................................................................................................................... 16

**Chapter 3: Research Methodology** ................................................................................................................. 17

3.1 Research Design Overview ............................................................................................................................ 17
3.2 Literature Review ......................................................................................................................................... 18
3.3 Exploratory Study ......................................................................................................................................... 19

**Chapter 4: Theoretical Work** .......................................................................................................................... 20

4.1 Usability ......................................................................................................................................................... 20
4.2 Role of Mobile Applications in Physical Fitness ......................................................................................... 21
4.3 Usability Importance for Mobile Applications ............................................................................................ 22

**Chapter 5: Usability Test** ............................................................................................................................... 25

5.1 Planning for Usability Test ............................................................................................................................. 25
5.2 Selection of Users ....................................................................................................................................... 25
5.3 Test Environment and Equipment ............................................................................................................... 26
5.4 Conduction of Test ...................................................................................................................................... 26
5.5 Analysis of the Usability Test ........................................................................................................................ 27
  5.5.1 Activity 1: ............................................................................................................................................... 27
  5.5.2 Activity 2: ............................................................................................................................................... 27
  5.5.3 Activity 3: ............................................................................................................................................... 27
  5.5.4 Activity 4: ............................................................................................................................................... 28
  5.5.5 Activity 5: ............................................................................................................................................... 28
5.6 Usability Test Findings ................................................................................................................................... 31
5.7 Questionnaire ............................................................................................................................................... 31
  5.7.1 Questionnaire results ............................................................................................................................. 31
  5.7.2 Questionnaire analysis ........................................................................................................................... 33
5.8 Interview Results .......................................................................................................................................... 36
  5.8.1 Overview of interview ............................................................................................................................ 36
  5.8.2 Interview analysis ................................................................................................................................ 36
  5.8.3 Analysis of responses given to questions about suggestions of usability improvements .... 37

**Chapter 6: Discussion and Validation** .............................................................................................................. 38

6.1 Discussion ...................................................................................................................................................... 38
  6.1.1 Usability quality components.................................................................................................................. 38
  6.1.1.1 Learnability and Memorability ........................................................................................................ 38
  6.1.1.2 Efficiency ......................................................................................................................................... 38
  6.1.1.3 Error rate ......................................................................................................................................... 38
6.1.1.4 Satisfaction .................................................................................................................. 39
6.2 VALIDITY DISCUSSION ..................................................................................................... 39
  6.2.1 Credibility ..................................................................................................................... 39
  6.2.2 Dependability ............................................................................................................... 39
  6.2.3 Transferability .............................................................................................................. 39
  6.2.4 Confirmability .............................................................................................................. 39
6.3 RESEARCH QUESTIONS ANSWERS ............................................................................... 40

CHAPTER 7: CONCLUSION AND FUTURE WORK .................................................................... 41
  7.1 CONCLUSION .................................................................................................................. 41
  7.2 SUGGESTIONS ............................................................................................................... 41
  7.3 FUTURE WORK ............................................................................................................... 42

REFERENCES .......................................................................................................................... 43
  6.4 APPENDIX A .................................................................................................................. 46
  6.5 APPENDIX B: SCREENSHOTS OF ACTIVIO APP ...................................................... 47
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICT</td>
<td>Information communication technology</td>
</tr>
<tr>
<td>eHealth</td>
<td>Electronic health</td>
</tr>
<tr>
<td>A app</td>
<td>Activio app</td>
</tr>
<tr>
<td>AFS</td>
<td>Activio fitness system</td>
</tr>
<tr>
<td>MHR</td>
<td>Maximum heart rate</td>
</tr>
<tr>
<td>AW</td>
<td>Activio workout</td>
</tr>
<tr>
<td>PDA</td>
<td>Personal digital system</td>
</tr>
</tbody>
</table>
CHAPTER 1: INTRODUCTION

This chapter describes motivation related to the background knowledge. Related work and a brief introduction about the structure of the thesis is also discusses in section 1.2 and 1.3.

1.1 Background and Motivation

The topic of this study is usability and motivational aspects of mHealth wellness technology for supporting a healthy life style. The main focus of this thesis is on how to measure and evaluate usability and motivational aspects concerning mHealth wellness applications for supporting a healthier lifestyle. The main question being addressed is how mHealth wellness applications can be designed to be satisfying to use and motivate continuing use over time, in order to support and sustain a healthier lifestyle and to make a long-term impact on user’s lives.

It was made possible by the evolution of information communication technology that has transformed the field of healthcare. This is conceivable thanks to the recently created technologies and improvements made in smartphones, tablets and social networks that have led to a branch in eHealth called mHealth [1]. mHealth is a term coined for the use of mobile and wireless devices to improve health outcomes. This outstanding diversification of smartphones and tables has accommodated the creation of a new branch in the industry of software, the development of mobile applications or apps, understood as programs for smartphones and tablets which can be downloaded directly from a commercial store in the device [2].

A large number of health application aimed at making it easier for people to control and monitor several aspects of their daily life (e.g. nutrition) and daily activities (e.g. physical activity/exercise). Some of these applications may be used to alter lifestyles, motivating the user to be more active and/or change certain behaviors [3]. There are now thousands of new applications focusing on wellness, fitness and nutrition. mHealth applications are on the rise. According to a report published in 2012, there were already at that time more than 500 mHealth projects worldwide and approximately 40,000 medical apps available for smart phones and tablets [4].

In this thesis, the usability and functionality of the ‘Activio App V.1.0’ application will be tested and explored from the perspective of trainers/students managing their physical activities. The ‘Activio fitness system’ is a mobile application developed by the ‘Activio AB’ consultant company. It is based on an application, which provides a complete solution for heart rate training. The ‘AFS’ application was developed to encourage and support peoples by putting their heart into training individually and in group. With wireless and easy to use equipment one get honest, objective, individual and immediate feedback during training – enabling you or your trainer to instantly adjust your work out to your goals. ‘AFS’ includes an activio smart built and Activio Intensity meter which are combined to provide a mobile based solution to help and motivate peoples. ‘AFS’ makes it easier for the trainers and peoples to ensure adherence to their physical activity, and gives the trainers a tool to support and monitor the trainees through enhanced dialogue. It is expected that this will contribute to public health and health care in two ways, first of all through healthier trainees and secondly
through lower costs for fitness care and society. However, this is dependent on if the peoples find the application appealing and motivating to use. How such aspects of an mHealth wellness application can be measured and evaluated is the main focus of this thesis?

Usability is considered as important for the system acceptance by the end users. Being a well-known concept in design and health care development. The concept has its roots in the development of information and communication systems and Human-Computer Interaction (HCI) [5]. Usability is referred to the international standard organization definition as: “The extent or degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use” [6]. Besides a user perspective and an aim towards creating beneficial solutions that are effective, efficient and satisfactory, the context of use is considered important and as having quite an impact on usability work. Focusing on the context of use demands for an understanding of the context before, during and not the least, after implementation when the product is in use [5]. This means that usability work must be included in all steps of the development process.

Now days, technology has been powered by mHealth, such as smartphones, to guide and improve public health. Relatively one in five smartphones users utilize at least one software application to support their health-related goals and its worth to mention that 38% of health app users have downloaded an app for physical activity [7]. Therefore, in recent years mHealth solutions have been used to assist not only doctors but also trainers/caregivers, in addition to patients suffering from a wide variety of diseases [8]. Regardless of the number of technologies and applications developed, they will lose their importance if they are not used by anyone. The rapid development of these mHealth apps runs parallel to the societal changes that we are experiencing in our day to day life in the form of aging and so on. However, the main problem in mHealth is not the lack of technology [9]. But how to take advantage of it when it comes to motivation, usability, user experience and customer satisfaction.

The main objective of this study is to examine the usability related problems of the selected mHealth wellness application concerning the goal to efficiently and effectively supports trainers in particular and the public in general. In addition, approaches for enhancing the usability of the mHealth wellness application were also inspected.

2.2 Related Work

mHealth which is a part of eHealth appears to have enormous potential for improving the quality of life of people. To address the issue of lack of exercise and motivation to do fitness activities, smart phones and personal digital assistants (PDA) are playing a pivotal role; they have made it easier for trainers/peoples to record their medical/physical data and provide support for wellness care professionals to analyze the distant collected data from the trainees and to provide proper advice and guidance to the trainees when required. As a result of the collected data, trainees can check the status of their physical activities ubiquitously. Interaction design and usability issues have become especially important for conveying fitness status effectively from often complicated data, so that trainers/peoples can understand the ramifications of information presented for their self management of health.
It was observed that the increase in the accessibility of mobile information in ubiquitous computing has made the use of mobile phone a common way of communication [10]. Furthermore, to cope with the costs for services in the form of ambient intelligence technology or in a decrease of service quality or both there is a need to provide some proactive and situation aware assistance to maintain the autonomy of elderly. To enable elderly people to live longer in their preferred environment and to enhance the quality of their lives and to reduce costs for public health system and society, Vitor et. al (2013) developed and tested a new web-based rehabilitation tool that provides intensive cognitive training at home under clinical prescription and monitoring at affordable costs. This new web-based system was very well accepted by patients and their relatives, who showed high levels of satisfaction and motivation to use it on a daily basis. Furthermore, the simplicity and comfort of its user were especially outlined by increasing the patient access to specialized health care and improving the quality and reducing the national health system costs of rehabilitation programs [11]. In efforts to enhance the user experience, mobile fitness applications are beginning to integrate gameplay mechanics and social elements in their design. To shape this into reality, Frank (2014) conducted a diary study on a group of five experienced iPhone users to determine if the app’s social elements improved motivation and lead to a short-term positive behavior change. Data was collected over a week from 15 mobile app users and runners with an online diary study followed by short interviews. The analysis of the diary entries indicates that apps can provide satisfaction and motivation to maintain or increase physical activity. In addition, it further shows that mobile fitness applications can help: increase confidence, achieve specific goals, improve wellbeing and provide motivation to maintain or increase physical activity [12].

Though the applications are meant for everyone, Direoti et.al (2015) carried out a study on the effectiveness of two mobile apps as a stand alone instrument for improving fitness and physical activity among young people. As physical activity is a modifiable behavior and therefore can play an active role in preventing non-communicable diseases. The study shows that common interactive technologies such as smart phones, particularly applying captivating features, may enhance the appeal and delivery of interventions to increase levels of physical activity in young people. In addition, secondary outcomes could be enhanced physical activity levels, enjoyment, acceptability and usability of the apps [13]. If effective, such applications could be used alongside existing interventions to promote fitness and physical activity in the population.

There is an identified need for objective, reliable and scalable methods of measuring and recording sleep. Such methods must be designed for easy integration into people’s lives in order to support both sleep therapy and everyday personal informatics. For this purpose, Shaun et.al (2013) carried out a study on the design and evaluation of a mobile phone application in order to record sleep, the design of which provides an excellent tool in clinical sleep research [14]. They carried out two user studies which demonstrates that the application produces valid measurements of sleep quality and high levels of usability. During the time there occurs no seriously disturbing sleep and the sleep environment. Hence their finding suggests that the app is suitable for both everyday sleep monitoring in a personal informatics context and for integration into sleep interference.
Mobile health technologies have recently been used to deliver behavior change interventions. In a study, Pfaeffli et.al (2015), performed a mixed-methods study to examine the effectiveness of an mHealth intervention to increase exercise behavior in adults with IHD (Ischemic Heart Disease). They concluded that text messaging is a good way to deliver exercise information until and unless mHealth is designed in an automated manner to improve the program’s need for reminders etc. to be delivered according to individual needs [15]. The program motivated participants to exercise. Adults with IHD were able to use an mHealth program and reported that text messaging is not even useful to deliver exercise information but in addition mHealth must be designed to be automated and hence programs might be improved if content and delivery were tailored to individual needs.

To identify the necessary features and functional requirements of mobile apps for chronic disease self management, Ramachandran et.al (2014) conducted a qualitative study. It is based on extensive literature survey followed by review of Top 10 Healthcare apps. The aim is to facilitate the users to understand the self-management information of their chronic disease and would help to arrive at a consensus on what will be included in the proposed mobile app [16]. Furthermore, to identify the usability problems in the user interface design, a usability inspection method called heuristic evaluation was used. Nielsen and Molich proposed HE and it has been championed as a useful low-cost inspection method to professionally evaluate software usability [17].

2.3 Structure of the thesis

Following is a brief overview of all the chapters covered in this thesis.

Chapter 1 (Introduction) Section 1.1 discusses about the background and motivation, Section 1.2 discusses related work and Section 1.3 is about the structure of this thesis.

Chapter 2 (Problem definition) describes the problem definition and usability evaluation of mHealth wellness app (Activio). Section 2.1 deals with the problem definition. Section 2.2 deals with mobile health. Section 2.3 deals with mHealth wellness application (Activio). Section 2.4 deals with the aims followed by objectives and section 2.5 is about the research questions.

Chapter 3 (Research methodology) presents the research methodology of this thesis work. Section 3.1 provides an overview of the research design carried out in this thesis. Section 3.2 deals about the literature review and section 3.3 deals with the exploratory study.

Chapter 4 (Theoretical work) is a brief discussion about theoretical study that I carried out. Section 4.1 gives a brief introduction of usability. Section 4.2 deals with the role of mobile application in physical fitness and section 4.3 deals with the usability importance for mobile applications.

Chapter 5 (Usability test) discusses a detail empirical work of usability test. Section 5.1 deals with choosing participants. Section 5.2 is planning for usability tests. Section 5.3 and 5.4 is about the test environment and conduction of test. Section 5.5 is about the analysis of the usability test and the activities that has been carried out during the test. Section 5.6 is about usability test findings and section 5.7 is about questionnaire, results and analysis. Section 5.8 is about the interview results, overview of the interview, analysis and analysis of responses given to questions about suggestions of usability improvement.
Chapter 6 (Discussion and validation) describes discussion and validation. Section 6.1 deals with the discussion on usability quality components in detail. Section 6.2 deals with the answers of the research questions. Section 6.3 deals with the validity and reliability of results.

Chapter 7 (Conclusion and future work) describes the conclusion of thesis. Section 7.1 deals with conclusion. Section 7.2 deals with the suggestions. Future work is also described in section 7.3
CHAPTER 2: PROBLEM DEFINITION

This chapter relates to the problem definition which points to those problems that are creating difficulties while using the activio app during exercise. A brief introduction of the app is also discussed in this chapter. Furthermore, aims and objectives in section 2.4 and research questions in section 2.5 is also discussed.

2.1 Problem Definition

Today there are lots of communication devices available in the market. These devices typically include PDA, smartphones and tablets. Their development has led to the proliferation of applications (“apps”), which are program able to run on these devices [18]. These devices presently represent a significant presence in people’s everyday lives and are expanding rapidly, ranging in complexity from products as simple as patient booking and point-of-care electronic physician note apps to sophisticated remote patient monitoring [16]. Independent of place and time they enable access to different types of information. Such widespread connectivity offers significant potential in different application areas including health and wellness care [19]. Hence the use of mobile computing and communication technologies in health care and public health has become a rapidly expanding area of research and practice. mHealth programs and applications use mobile electronic devices and mobile phones for a range of functions from clinical decision support system and data collection tools for health care professionals to wellness applications for personalized health promotion for patients with chronic disease for people in general who wish to live a healthy life [19] [20]. By applying features adopted from games, the mhealth applications are endowed with support for user engagement, motivation and encouragement [21].

The prevailing sentiment is that well-designed health apps will help consumers make better decision, about their health behaviors or health-care/wellness options. To strengthen the argument one of the most popular mhealth wellness app iTriage has more than 8 million downloads till date [4]. However, not all apps are equivalent: consumers, providers and payers continue to search for high quality apps in a market that has not yet found a way to “vet” app, and we cannot be sure that adoption rates measure anything other than purchases or downloads [4].

Irrespective of the number of apps developed, app developers have to take measures such that their mobile application is accepted by both trainers and the trainees and other end users who use it. It is a common mistake done by the developers while developing an application that they ignore a functionality which is essential. Ignoring it will not only lead to discredit the application but also might affect lives. Therefore, to highlight such issues developers often use a user centered design approach.

In this study usability issues of the selected mHealth wellness application (Activio) concerning the aim to efficiently and effectively motivate trainers/peoples is carried out and the focus has been made on the interface of the app used by trainers and peoples.
2.2 Mobile health

According to Gustafson, e-health is defined as “use of the internet or other electronic media to publish health related information or services” [22]. In a broader sense the term characterizes not only a technical development, but also a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally and worldwide by using information and communication technology [23].

The progress made by the recent technologies like smartphones, sensor networks and social networks have led to a new branch in eHealth called mHealth. mHealth is a term coined for the user of mobile and wireless devices to the wellbeing of humans. According to World health organization (WHO) Global Observatory of eHealth (GOe) defines mhealth as, “medical and public health practice supported by mobile devices such as mobile phones, monitoring devices, personal digital assistant (PDAs) and other wireless devices” [24].

In a more simplified form m-Health is the delivery of health care services or information with a mobile phone for remote monitoring, education, consulting etc. [25].

The usage of information and communication technology (ICT) in health care practice has introduced the concept of eHealth, because peoples have always utilized the available important resources to protect their most valuable assets and no asset is more valuable than their own health. Telecommunication is enabling telemedicine, health data are processed by computers and all sorts of medical information and services are provided by internet. When mobility become possible, telecommunications occurred through mobile phones, and therefore computer moved along with people in the form of portable laptops and then hand held devices [26]. The eHealth expanded to include mobile health (mHealth). The unique property of mHealth, and particularly that based on smartphone apps is that it has multiplicates very fast, surpassing the governmental efforts in regulation, as well as the health informatics researchers in study and evaluation. It is because of the diversity of apps, that has targeted health professionals, patients, physiotherapist, fitness trainers’ in particular and the public in general.

According to a March 2013 report by research2guidance, a Berlin based company, the market for mHealth app services is predicted to reach US$ 26billion world-wide by 2017. The report, “Global Mobile Health Market report 2013-2017” suggests that mobile application developers have begun to enable the mHealth industry to successfully monetize their services and enter the commercialization phase [27]. It is the result of this flourishing market and acceptance of smartphones and tablets that has aided their usage in health systems., thus leading to the evolution of the term mHealth [24].

2.3 Mobile application (Wellness) Activio

The mHealth application Activio (V.1.0) in this study was provided by a company participating in developing wellness applications. The company name is ACTIVIO AB. The author has given a detail description of the app and its usage by the peoples based on different requirements and potentials. Based on different goals, it helps you to reach those goals by putting your heart into training by removing the assumptions. [28]. With Activio Fitness System, users get the instant feedback and detailed progress reports removing the guesswork from their training and inserting hard, measurable results. The motivating power
of being able to monitor your exact heart rate is phenomenal, helping users on all levels to improve their wellness performance and get the results they want. AFS is made of the following four components and is also shown in section appendix B by screen shots.

Digital ChestBelt
Touch Screen
Heart Rate Display
After-Workout Feedback

1. Digital ChestBelt/Activio Smart Belt
   It has the functionality to monitor and at the same time transmits heart rate data wirelessly. It has the ability to update heart rate every second and hence no charging is needed. It is the only personal heart rate chest belt that can be used with all Activio systems. All heart rate data are cloud-synced automatically to the members’ MyActivio.com account, making it easy to track, analyze and plan training.

2. Touch Screen
   It is composed of a central control unit with a touch screen. It has an interface for quick and easy user login and instructor control.

3. Heart Rate Display
   It anonymously presents every user’s exact and current heart rate. Amazingly motivating for users on all levels. If an app name Activio Virtual Trainer is installed, participants can also follow the instructor’s route for the class, making it easy to prepare and plan his/her workout.

4. After-Workout Feedback
   MyActivio.com is a personal feedback solution which automatically uploads members’ recorded training data to a personal training diary on the web. As it is extremely user friendly, therefore you can track and analyze heart rate data and progress, making it easier and more fun. It is further composed of the following main components to interact with.
   a) Plan: Training Calendar
      The personal training calendar can be accessed by club members from any computer over the internet, and represents a quick overview of your training schedule, as well as your updated results.
   b) Analyze: Charts
      The training data is automatically uploaded after each workout as a pulse curve and presented on myActivio.com in an easy to follow charts. By using the integrated tools, users can shape and modify their feedback curves to make detailed analysis of their performance in every workout. There is even the possibility to comment and share workout results on social media like Facebook.
   c) Track: Reports
      All previous training data is stored, enabling myActivio.com to generate over time reports. This make it easy for users and instructors to follow progress on an individual level and plan future training programs.

2.4 Aims and Objectives
   The aim of this research is to identify usability issues and motivational aspects related to the interaction design of an mHealth wellness application for
managing one’s own fitness and health. The aim is further to explore how usability and motivational aspects can be measured and evaluated for mHealth wellness applications for a healthy lifestyle. The results of the project are expected to support developers in understanding the needs and expectations of users while using these applications and continue use over time.

The objectives of this research are:

- To perform usability evaluation testing on an mHealth wellness application.
- To explore motivational aspects of mHealth wellness application and how these can be measured and evaluated.
- To explore how usability testing results can be conferred in order to efficiently inform and compliment the development of mHealth wellness applications.
- Choosing performance and satisfaction measures.
- To identify the acceptance criteria of user performance and satisfaction on mHealth wellness applications.

2.5 Research Questions

**RQ1:** During mobile health application development, what role does usability evaluation and considerations concerning design for motivation play?

**RQ2:** What issues concerning usability were involved when studying/developing a mHealth application for wellness by keeping the user satisfaction and motivation in mind?

**RQ3:** What suggestions of improvements based on the identified usability issues and requirements and motivational aspects in mHealth wellness application can be made for improved/future technology?
CHAPTER 3: RESEARCH METHODOLOGY

In this chapter the author present research methodology overview and procedures followed in the literature review to discuss usability evaluation of Activio app for fitness through usability testing. The procedures define usability evaluation method; usability testing as a Think-aloud protocol technique for observing participants during the test and also by conducting interviews with the developers to validate the results.

3.1 Research Design Overview

In this thesis, the author has followed a mixed method approach. A literature review and exploratory methods were used. Since the main aim of the thesis is based on investigating a specific mHealth wellness application (Activio) which supports a physical activity and the focus will be on the interface of the mHealth wellness application used by the trainers. Therefore, the literature review was chosen as a sufficient way of collecting basic information regarding usability issues and which usability evaluation method should be selected for evaluating the usability of the mHealth wellness application.

There are different usability evaluation methods and techniques however preference is given by the author to usability testing as evaluation method and Think-aloud protocol technique as usability test on end-user. In think-aloud protocol technique a participant is given some tasks to perform. The participant speaks loud his thoughts while performing these tasks so the evaluator has a clear idea of what the participant has on his mind while interacting with the system [29]. The main advantage of this method is that an evaluator is able to judge easily from the user’s action what he/she thinks about interface during interaction. In addition, the evaluator also gets the chance to figure out what problems a user faces while interacting with the system [30].

Figure 1 exhibit that the author has done relevant literature review in order to get an in-depth understanding of Nielson’s principles for defining the role usability evaluation and considerations concerning design plays (RQ.1). Relevant usability requirements for user interface of Activio app are identified. To evaluate user performance and satisfaction, think-aloud learning technique is used for conducting test on end-users (trainers and students). Interviews are conducted to validate the test results and questionnaires were distributed to collect user’s satisfaction (RQ.2). In the end a discussion has been done on findings and users feedback in order to provide possible suggestions and recommendations for the improvement of the Activio app user interface (R.Q.3).
3.2 Literature Review

In the literature review phase, the initial step is to conduct a literature study to get an in depth review of methods used for usability testing. It is through this study that I will be able to find studies related to the problem definition and different evaluation methods. Furthermore, it helps to define the topic and position the thesis project within the selected area and clarifies how different evaluation methods are currently being used in the design and development of mHealth wellness applications. Research about different mHealth wellness applications will also be studied in the review phase. Different evaluation methods i.e. Question-asking protocol, remote testing, shadowing method, teaching method, think aloud and co-discovery learning method will be studied with a primary focus on think aloud method. In addition, usability problems which cause people to avoid or reject using smart phones for mHealth are also studied, and related to motivational aspects, that is, what motivates people to use mHealth applications and to continue using them over longer period of time. A questionnaire/Survey will be prepared based on the literature review. In the second phase of the study, the literature review will play a pivotal role for designing a usability test and presenting the results of the test in ways that can efficiently inform interaction design when an mHealth application for wellness is developed.
3.3 Exploratory Study

An exploratory study is a research conducted for a comprehensive study of a problem or phenomena within its real-life context [31]. The essential part of this study is to find out the usability issues faced by trainers while using Activio system, a mHealth fitness application for managing physical activities which has been developed by the Activio AB consultant company. In my work, an application named Activio (V. 1.0) will be used to study usability and motivational aspects involved when developing an mHealth wellness application. A usability test will be conducted to diagnose usability issues and will be carried out on two groups. One group will consist of trainers that are involved in using Activio system and the other will be BTH students. Data will be gathered via think aloud technique where individuals explain aloud what the perceived usability issues of the application are when they carry out certain activities. The data collection and analysis procedure will be carried out in two steps. The first step will involve the collection of observations and the second step will be to analyze the observed human behavior when dealing with the designated activities [32]. Full audio taping and/or video recording of the subject and his/her parallel articulations via think aloud technique during activity performance, and if relevant, video recording of the computer screens, is require to capture all the verbal data and user-computer interactions in detail for the following analysis steps.

As a part of this study, data will be collected not only through usability testing and observation but also through a survey. Surveys will be conducted in two ways i.e. questionnaires and interviews. The target will be trainers having the desire to carry out physical training and therefore having received applications for specific personalized programs for fitness activities. The reason for selecting this method is, a questionnaire helps to prevent deviating from the main topic of the study, in comparison with open ended interviews. Also, a questionnaire is more practical when it comes to gathering large amount of data from a large number of people in a short period of time and therefore makes it more cost effective. The questionnaire will contain both open ended and closed ended queries. It will be including questions related to usability problems, functionality, interactive design and anticipated needs concerning mHealth fitness application.

At a later stage results from observations and questionnaires will be evaluated and compared. This will provide a footing for a detailed work about observed and perceived usability issues concerning mHealth wellness applications for trainers and students. The result obtained from the survey will further contribute in the validation of results from the usability testing and will also contribute to informing developers about how to enhance mHealth fitness applications when it comes to perceived usability issues and motivational aspects.
CHAPTER 4: THEORETICAL WORK

In this chapter, the author has discussed usability and Jacob Nielsen usability quality component. Furthermore, the role of mobile application in physical fitness and importance of usability for mobile application is also discussed.

4.1 Usability

According to the International standard organization for standardization (ISO) standard ISO-9241, usability is defined as “the extent to which a product can be used by the specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” [6]. Usability is an important factor in mHealth wellness applications, especially for peoples who may find it complex to interact with smartphones, PDAs etc.

Probably the best definition of usability is by Jacob Nielson [6], when it comes to the quality components (criteria). The five quality components that define usability are learnability, efficiency, memorability, errors and satisfaction.

1. Learnability: It is about learning and getting used to the interface of the system in order to get maximum benefits after using it. It is also worthy to mention that how easy is it for the users to achieve basic tasks the first time they encounter the design of an application.

2. Efficiency: A system is said to be efficient if the usage of the system is expected to have a good level of productivity in relation to the accuracy and completeness with which users achieve goals.

3. Memorability: A system is said to be memorable, if the users who have experience with the system but have not used it for some time are able to return to the system and use it successfully.

4. Few error rate: The user gets an error whenever he/she fails to perform a task. Therefore, the system must have the capability to withstand errors. The users may desist on the system if they encounter too many errors or if the errors are managed badly. Hence, this quality component is not only about number of errors, but also about the severity of errors and how easy it is for users and the system to comeback from errors.

5. Satisfaction: The satisfaction of the users plays an important role when it comes to the usability of the product. Because it is something that that user gets freedom from discomfort and positive attitude to the use of the product. Therefore, a user is said to be satisfied if he/she is able to get the desired benefits from the system and if the design is perceived as pleasant to use.

According to Shneiderman (2000), main usability attributes are learning time, performance speed, time needed to recover from errors, error rate by the users and satisfaction [33]. According to the ISO 9241-11 standard, **usability is defined as the effectiveness, efficiency, and satisfaction with which specified users achieve specified goals in particular environments** [6]. Below table 1 gives a comparative overview of the usability quality (components) proposed by Nielson, Schneider and ISO 9241-11.
Table 1 Usability quality (components) (Source: Novak (2014)) [34]

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td></td>
<td></td>
<td>Performance</td>
</tr>
<tr>
<td>Learnability</td>
<td></td>
<td></td>
<td>speed</td>
</tr>
<tr>
<td>Memorability</td>
<td></td>
<td></td>
<td>Retentionover</td>
</tr>
<tr>
<td>Error</td>
<td></td>
<td></td>
<td>time</td>
</tr>
<tr>
<td>Satisfaction</td>
<td></td>
<td></td>
<td>Users rate of</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>errors</td>
</tr>
<tr>
<td>Satisfaction</td>
<td></td>
<td></td>
<td>Satisfaction</td>
</tr>
</tbody>
</table>

The Nielson Norman group (NN/g) is a significant user experience research, training and consulting firm which was founded in 1998 by Jacob Nielsen, Donald Norman and Bruce Tognazzini [35]. They have done influential work in usability testing, in recent years they did an outstanding work on user experience of mobile devices, including tablets and iPads etc. By keeping the aforementioned view, the author has decided to select the quality components proposed by Nielson.

4.2 Role of mobile applications in Physical fitness

Mobile applications are sophisticated programs or special applications that runs on handheld devices such as smartphones or tablets [36], that offers advanced communication and allow providers to assist peoples improve their way of life in real time, enabling them to personalize fitness care options and monitor progress. Mobile devices which were previously used for voice communication and text have changed dramatically into handheld computers with computing capabilities that include internet access and geo-positioning system [37]. The advantages offered by mobile applications in the field of healthcare and wellness appear to be tremendous. They encompass the ability to affect the cognitive, and social responses involved in living with an illness, and may contribute to the much discussed primary care “medical home” model for improving healthcare outcomes. Health-related wellness apps are covering a variety of areas designed to help people take a proactive approach to their fitness, health. Many of these have been tested in an effort to evaluate and refine the process of positive behavior change and maintainace over the long term [36]. Therefore, the use of mobile apps offers a highly accessible and cost-effective means of implementing motivational and self-management programs.

With the ubiquitousness of mobile devices in our day to day life, the impact of mHealth is substantial and includes improved people involvement, strengthen data sharing and connection and also communication between peoples/patients and providers. Therefore, wellness devices allow people to set goals, motivate them for acquirement, provide tracking abilities and real-time monitoring [38]. Because of smartphones as a more recent advance, wellness providers are able to pass their services to the intended target, which also reduces the number of visits to the wellness center. Thus enabling trainers to monitor remotely by observing the inputs from the users. Hence efficient utilization of time can be observed when mHealth wellness applications are used efficiently and to the full extent of their potential.
4.3 Usability importance for mobile applications

Usability involves the design of the products or system as the user should be able to perform tasks with the system efficiently. Users desires to interact with the system which are simple, interesting and satisfying as well. If they feel distressing with the interface, it may lead to repeal of the system or product, which on a large scale could ultimately leads to the failure of the system or product within the market. Hence users do not show much interest in complex interfaces [39]. Its worth to mention that involving users in the development process of a system with the desire of developing a system according to their requirements is an area where usability has proved to be an effective and efficient approach and tool. To strengthen the argument with an example and to show the importance of usability as a way of engaging users in design discussions, a professor Tim Frank Andersen from the Technical University of Denmark, reviewed 70 software products in different magazines and got 784 comments regarding the usability issues of the software. Many of these comments were reasonably cosmetic, but their sheer number indicates the importance of usability in today’s market [39].

Transformation has taken place from the desktop computers to the handheld devices due to the fast growth in the usage of wireless devices and their ability to perform complex actions. In order to motivate the people to use these applications, it must be ensured that usability of the applications must be taken into account from the start and measured during the development process to minimize the usability problems as minimum as possible when the applications reach the market. Therefore, an application which is interactive/participative will be successful, until and unless if the activities assigned to the users are able to perform the desired tasks successfully in an efficient manner. Issues will arise with learnability and memorability even if the functionalities of the application perform well and will feel displeased and inefficient or face errors when using the application and therefore will results in a view that mobile interface is not said to be good and usable. Issues like said before have led the developers and designers of applications to focus on usability and this has resulted in the fact that usability has come to play a key role in developing an application. From the start in design and development, the criteria for usability evaluation are considered to ensure the success of an application when it comes to feasibility.

In the defined literature found on usability of mobile phones, it is clear that the evaluation methods that are used for web are also being used for mobile and hence there seems an overlap between usability methods of web and mobile applications. Yet, in the case of mobile phones, usability explicitly involves context of use factors and therefore, the context of use includes task, environment, social and technical component [40].

Before usability evaluation, goals are set for usability attributes which are used for usability judgment criteria of a product and assigning different metrics to those attributes which allow measures for specifying the usability of a product. Therefore, usability evaluation is performed to identify the usability issues of an application [29]. Its worth to mention that the reason for performing the usability evaluation is to test the application to ensure that it meets the intended needs of the users when they interact with it. Through iterative usability evaluation, problems that encompasses during the development process and that affect the interaction design can also be identified [23].
According to literature, Usability evaluation methods applied for mobile communication are classified into:

(a) Testing: It is a process in which we can learn from users about usability problems by observing them performing a set of different tasks.
(b) Inspection: With this method, usability experts are involved to set up a list of criteria to identify usability problems.
(c) Inquiry: To explore the perceptions, experiences, views and choices of the participants, inquiry method is used.

Testing: Testing is a process in which we can learn from users about product usability by observing them performing different tasks [29]. In testing, a set of tasks defined by the experimenter are performed by the users on either a fully functioning system or prototypes. The empirical data is collected by the experimenter when the user performs the assigned task [41]. Data include time taken to perform the task that includes the successful and unsuccessful tasks, levels of performance, number of errors and user satisfactions. In usability testing, think-aloud and co-discovery techniques has proven to be more effective. In the think-aloud technique the participant speaks loud his thoughts while performing these tasks so the evaluator has a clear idea of what the participant has on his mind while interacting with the target system [30]. Therefore, it is used to gain insight into the mental understandings of the user when they interact with the application, which in turns helps the user in two ways; to identify the effectiveness of the application and secondly to the satisfaction or frustration of the users [39]. In co-discovery technique, the tasks are observed by the tester performed by a group of two participants. However, in this case both the users are allowed to work in collaboration and verbalize their thoughts by talking to each other while they perform the given tasks [30].

Inspection: Being a reasonable alternative to testing. Inspection refers to a set of criteria evaluated by usability experts in order to identify the usability problems related to user interface. Generally, usability inspection is aimed at finding usability problems in a design [41]. Inspection methods proves to be cost effective where the prototypes can not be tested on the users at the initial stage of the development process [39]. The methods that are most commonly used in usability inspection are cognitive walkthrough and heuristic evaluation. In cognitive walkthrough, the evaluators place themselves in the shoes of users and depicts how a user would interact with the application in their first use with it. Rather then referring to a manual, user goals are identified through analysis and users’ problems are identified by the evaluators when interacting with the application. In heuristic evaluation technique, a group of usability testers compare an application against a list of predefined usability principles (heuristics) to identify in a user interface design the usability related problems [41] [23].

Inquiry: Inquiry is a process in which user requirements are identified by an evaluator for an application by getting the required information via observation and/or by communicating with the users [23]. Inquiry is accomplished by the following evaluation techniques: surveys, logging actual use, proactive field study, focus groups and field observations. In survey data are collected manually on the results, when the problems are encountered with an
application or device [42]. By logging actual use means the device collects the data rather than doing it by manual intervention [39]. Proactive field study is used at the initial stage of the software development. Here evaluators go to the work or the daily environment of the users to make sure that their requirements, tasks and problems they encountered are identified [39]. Focus group means when the peoples assembled informally to discuss on a specified topic or task. By doing so users’ views and their understanding regarding a specific topic or task can be observed [39]. Field observations include the observation of people interact with the application in the specified context of use [39].

It is necessary to perform usability evaluation of a system because without evaluation, designers cannot be sure that their software/application is usable and what the user wants [30]. Therefore, it is necessary to use appropriate techniques for investigation. The author has used think-aloud, interviews and questionnaires techniques to carry out the usability evaluation studies for this work. The reason behind the selection of think-aloud technique is, the results obtained would be expected to close to the user’s real experience. A brief explanation of Think aloud protocol is explained in section 3.3. In addition, the author also focused to accumulate observations on ease of use of application individually.
CHAPTER 5: USABILITY TEST

This chapter explains about planning and conducting of usability tests using think aloud protocol. Planning for the task requirements, test materials and test environment are discussed. Activities are designed for performing test on Activio app features. After performing usability tests; interviews are conducted to capture the developers’ perspective to validate the tests results. Questionnaire is designed according to Nielsin’s usability quality component.

5.1 Planning for Usability test

The explicit involvement of users has helped the author to compile information about the mHealth wellness application and therefore the evaluation of mHealth application was conducted in a coordinated manner. From a pool of knowledge available on usability tests and guidelines, giving advice on how to plan, conduct, and analyze usability tests in various contexts. The author used usability testing guidelines when conducting the usability tests [43]. The participants were given a brief presentation to what they were going to perform and also they were provided details about the activities that they had to do at the start of the usability tests. The usability test was conducted in two phases.

In the initial phase, the author went through the mHealth wellness application, Activio (V.1.0) to get acquaintance. The author then selected the activities that must be performed during the usability test. After that the author conducted a pre-test with two students and two trainers to ensure that narration of the tasks to be carried out were reasonable. Based on the pre-test results the author was able to obtained the quantitative measurement parameters.

In the second phase, the actual test to be carried out was conducted where observation was made and noted down by the author when participants interact with the system. A total of 20 (10 students and 10 trainers) participants participated in this test. Students were from computer science background. Its worth to mention that along with author, less then three persons have worked on usability topic as part of their course work. In addition, all the students have experience of using smartphones and at the same time being exposed to a number of mobile wellness applications. Where as in case of trainers some of the peoples did not have the experience of using the same application when it comes to fitness trainings. They often switch them based on efficiency and satisfaction after interacting with the application. Therefore, each individual was given five tasks and hence their interaction with the application was jotted down by the author accordingly.

5.2 Selection of users

Selecting users is sometimes challenging, mainly when the target audience is very specific. Therefore, the application should be tested with users who have similar age, education, social background and interest to the target user to say the least [43]. In the usability test, 20 (10 students and 10 trainers) have share their experience. The students are from BTH and so they were selected from a computer science background and trainers were selected from the lok and motion gym, Karlskrona based on their availability. Most of the students had experience in developing applications. To have a better understanding of usability tests and activities, the mode of communication has been selected as English. Therefore,
participants who were able to express themselves in English were included so that the author could make it convenient to collect the observations easily.

5.3 Test environment and equipment

Entire students have taken the test in a group room at BTH, whereas 5 trainers have taken the test at trainer’s room at Lok and motion Gym and the remaining five have taken the tests at their respective homes. Emphasis was given on the environment so that the participants feel free to move around in the room while they experience the application. The devices used to cover the whole process included a mobile phone, an audio recorder and a gadget for calculating time.

5.4 Conduction of test

The test was made convenient for students and trainers based on their availability and time at BTH and lok and motion Gym accordingly. The tasks that were done by the participants were observed and their interactions with the system were recorded. Span of the test and time taken for each task by each individual was jotted down by the author. Below Table 2 explains a more detailed description of the activities involved in the usability evaluation.

Table 2 Activity definition

<table>
<thead>
<tr>
<th>Activity definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A-1: Open a user account in the mobile application (Activio)</strong></td>
</tr>
<tr>
<td>a) Open the application.</td>
</tr>
<tr>
<td>b) Register an account.</td>
</tr>
<tr>
<td>c) Fill in username, password and email.</td>
</tr>
<tr>
<td>d) Fill in personal information.</td>
</tr>
</tbody>
</table>

| **A-2: For observing the report find the help guidance** |
| a) Navigate to the report page provided at the top extreme right. |
| b) When clicked this button, it gives the guidance of what the graphs in the report represents. |

| **A-3: Find the help guidelines to upload the fitness values** |
| a) Navigate to the My Activio Heart rate training at the top of the overview tab. |
| b) By clicking Training Plan tab, a page drop downs from the top which includes the guidelines to upload the fitness values. |

| **A-4: Share the results through email** |
| a) Navigate to the training plan provided at the top of the screen. |
| b) At the top of the screen there is a share button. |
| c) By clicking the share button, a page appears from the top where the user can select an application through which they can share the results. |
| d) In our case, Gmail application is used to share the fitness reports. |

| **A-5: Change the password for the account** |
| a) In the setting page, at the top right of the profile there is a tab by the name of Manage account. |
| b) By clicking on it, a drop down page consisting of the page Account settings the details of the registered person is presented. |
| c) At the left of the tab there is an option namely as Manage password. |
| d) After this a new page opens and it consists of three text fields as enter current password, enter new password and confirm password. |
After the usability test, the author asked for suggestions from the participants to improve the mHealth wellness application.

5.5 Analysis of the Usability test

As mentioned in table 2 above, each participant has provided with five activities. Initially at the start phase of the usability test, each participant was given instructions to “think aloud” and share their observations and suggestions regarding the interface during the test.

The results were classified into qualitative and quantitative data. It was the result of this data that a conclusion was drawn regarding the usability of the interface after analyzing it. The metrics used when collecting the required information are time taken to complete each activity, unnecessary touches for completing the activity and total time for the completion.

5.5.1 Activity 1:
The activity is to create an account for the mobile wellness application (Activio).

- For creating an account, most of the participants were satisfied with the interface. In order to register for an account, the steps were simple. Therefore, the participants were able to create an account without facing any problem.
- For registering an account, the user has to go through two pages.
- In the first page, the participant’s attention was drawn to the labels in the text field. When they typed in the fields, 2 participants snagged a second. Similarly, by placing the label outside text field, the users would be able to have a clear understanding of the input field when the want to modify the values in the text field in the middle of doing it.
- The second page is about the overview regarding the Heart Rate Training, my progress and my planned training. There are also few text fields for sessions uploaded, sessions per week and total uploaded heart beats. Therefore, participants felt interactive about the text fields and lists of trainings.

5.5.2 Activity 2:
The activity is to observe the reports which is found in help guidelines.

- During the process that author has observed that 14 (8 students + 6 trainers) out of 20 participants find it difficult to identify the tabs at the top of the interface of the application. But after multiple touches they were able to find the tabs.
- Participants experienced difficulty when trying to find the help guidelines because they were not able to differentiate the help icon from the rest of the interface. 13 (9 students + 4 trainers) out of 20 were not able to distinguish the help/information icon.
- The authors observe that 3 trainers and most of the students experienced difficulties in reading the contents of the help icon.

5.5.3 Activity 3:
The activity is to find the help guidelines to upload the fitness values.

- The participants were able to distinguish the icons for help from the rest of the interface. Mostly, the participants were successful in
identifying the help icon for uploading the fitness data. Therefore, participants felt that it was an attractive feature prior to enter the data the text filed highlights.

- But its worth to mention that majority of the participants did this task by mistake when they were trying to switch for a second task.

5.5.4 Activity 4:
The activity is to share the results through email by generating a report.

- The author is aware of the fact that almost every participant knows about the share icon. Therefore, all were successful in sending the data through email. However, 15 (11 students + 4 trainers) out of 20 participants felt that there is a minor difference of the colors between the share icon’s and the background color. They felt that it would be preferred if any of the color were made dark to differentiate between the icons.

5.5.5 Activity 5:
The task is to change the password for an account in the mobile application.

- The author has observed that 18 (12 students + 6 trainers) out of 20 participants were not able to find the option for changing the password when they intend to enter in the first go. Participants maneuvered/navigated to various tabs and finally they were able to find the manage account icon at the top middle of the interface under the profile option.
- After acquaintance with the icon, they were able to change their password without any complication.
- Most of the participants revealed that they did not receive any messages when they change their password but instead they got any email about the modified password.

It's worth to mention that all participants were able to complete the tasks. Table 3 and 4 below shows time taken for completing the activities.

<table>
<thead>
<tr>
<th>Cases</th>
<th>Total time(minutes)</th>
<th>A-1</th>
<th>A-2</th>
<th>A-3</th>
<th>A-4</th>
<th>A-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(P-T)</td>
<td>3:42</td>
<td>2:10</td>
<td>38s</td>
<td>7s</td>
<td>19s</td>
<td>28s</td>
</tr>
<tr>
<td>2(P-T)</td>
<td>2:92</td>
<td>1:55</td>
<td>20s</td>
<td>5s</td>
<td>40s</td>
<td>20s</td>
</tr>
<tr>
<td>3</td>
<td>3:21</td>
<td>1:40</td>
<td>51s</td>
<td>6s</td>
<td>35s</td>
<td>23s</td>
</tr>
<tr>
<td>4</td>
<td>4:10</td>
<td>1:59</td>
<td>1:10</td>
<td>5s</td>
<td>33s</td>
<td>26s</td>
</tr>
<tr>
<td>5</td>
<td>3:39</td>
<td>1:56</td>
<td>52s</td>
<td>7s</td>
<td>32s</td>
<td>21s</td>
</tr>
<tr>
<td>6</td>
<td>3:00</td>
<td>1:47</td>
<td>19s</td>
<td>4s</td>
<td>41s</td>
<td>41s</td>
</tr>
<tr>
<td>7</td>
<td>4:00</td>
<td>1:49</td>
<td>1:03</td>
<td>5s</td>
<td>35s</td>
<td>26s</td>
</tr>
<tr>
<td>8</td>
<td>3:46</td>
<td>1:54</td>
<td>40s</td>
<td>4s</td>
<td>30s</td>
<td>28s</td>
</tr>
<tr>
<td>9</td>
<td>3:48</td>
<td>1:58</td>
<td>41s</td>
<td>6s</td>
<td>35s</td>
<td>24s</td>
</tr>
<tr>
<td>10</td>
<td>3:18</td>
<td>1:51</td>
<td>31s</td>
<td>7s</td>
<td>31s</td>
<td>22s</td>
</tr>
</tbody>
</table>
Table 4 Summary of task duration (Students)

<table>
<thead>
<tr>
<th>Cases</th>
<th>Total time(minutes)</th>
<th>A-1</th>
<th>A-2</th>
<th>A-3</th>
<th>A-4</th>
<th>A-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(P-T)</td>
<td>4:42</td>
<td>2:17</td>
<td>1:27</td>
<td>17s</td>
<td>1:00</td>
<td>40s</td>
</tr>
<tr>
<td>2(P-T)</td>
<td>4:32</td>
<td>3:00</td>
<td>1:10</td>
<td>14s</td>
<td>58s</td>
<td>31s</td>
</tr>
<tr>
<td>3</td>
<td>5:40</td>
<td>3:10</td>
<td>2:10</td>
<td>18s</td>
<td>59s</td>
<td>50s</td>
</tr>
<tr>
<td>4</td>
<td>6:10</td>
<td>3:16</td>
<td>1:48</td>
<td>11s</td>
<td>1:36</td>
<td>34s</td>
</tr>
<tr>
<td>5</td>
<td>7:00</td>
<td>3:26</td>
<td>2:10</td>
<td>13s</td>
<td>57s</td>
<td>48s</td>
</tr>
<tr>
<td>6</td>
<td>7:14</td>
<td>2:52</td>
<td>2:13</td>
<td>8s</td>
<td>1:11</td>
<td>41s</td>
</tr>
<tr>
<td>7</td>
<td>6:18</td>
<td>3:00</td>
<td>2:00</td>
<td>12s</td>
<td>1:03</td>
<td>40s</td>
</tr>
<tr>
<td>8</td>
<td>4:34</td>
<td>2:00</td>
<td>1:38</td>
<td>18s</td>
<td>1:15</td>
<td>31s</td>
</tr>
<tr>
<td>9</td>
<td>5:51</td>
<td>3:12</td>
<td>1:12</td>
<td>10s</td>
<td>1:02</td>
<td>40s</td>
</tr>
<tr>
<td>10</td>
<td>7:19</td>
<td>3:33</td>
<td>2:10s</td>
<td>14s</td>
<td>1:11</td>
<td>30s</td>
</tr>
</tbody>
</table>

An interview has been conducted by the author after the usability test to discuss about the application and the experience they gained while navigating through the interface and summary of the observations has been shown in table 5.

Table 5 Summary of observations

<table>
<thead>
<tr>
<th>Activities</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>Generating an account is reasonable. Most of the text fields are well coordinated but its worth to mention that the font size needs adjustment. Navigating options for the text fields in both of the pages are attractive.</td>
</tr>
<tr>
<td>A-2</td>
<td>Participants experienced difficulty when trying to find the help guidelines because they were not able to differentiate the help icon from the rest of the interface. Therefore, change of color into a lighter one is suggested. The participants experienced difficulties in reading the contents of the help guidelines.</td>
</tr>
<tr>
<td>A-3</td>
<td>The background color has made the icon easily distinguishable i.e. black has made the help guidelines able to differentiate from the rest of the contents on the page.</td>
</tr>
<tr>
<td>A-4</td>
<td>The share icon which is not easily identifiable because of the darker color but it mixes with other content of the application and hence make it distinguishable.</td>
</tr>
<tr>
<td>A-5</td>
<td>Somehow manageable to identify the option for changing the password and hence confirmation for changing the password is also not shown.</td>
</tr>
</tbody>
</table>

During usability tests with the participants, the author was able to discover different problems encountered during interacting with the application. They were asked to play with the application and also presented with a paper prototype, where the results of using the application i.e. maximum heart rate, activio training zones, training effects, user list, class profiles for medium, light and hard trainings on the basis of intensity and a standard day report where all training levels are layered one above the other.

When the author presented the images of the report, some of the participants experienced difficulty in understanding the reports. For the activio training zones in the reports, participants were not able to clinch why there are different colors.
Although it means something, the participants were unable to determine which color represents what and when they navigate through the help guidelines, they were not able to find any help concerning the meaning of the different colors. Because with lack of knowledge about the training zones and their affects you cannot plan and accomplish your workouts optimally. 10 (4 students and 6 trainers) out of 20 participants were able to differentiate the colors as red means maximal, yellow means very hard, green means hard but workout can be done relatively long, blue and white means moderate and light respectively. But they also proposed that it would have been worthy if the color representation was mentioned in the help guidelines. When find your maximum heart rate was touched to find the perceived exertion level after performing the exercise with activio by 3 participants, the results if shown in the training mode would be beneficial. But later they realized that when the phone was oriented in the training mode they seem satisfied with what they want to achieve. Hence the author was in observation of the fact that they were not able to find this feature in their first interaction with the application.

The above figure 2 shows the time taken by trainers and students respectively. It can be observed that students have taken more time as compared to trainers for completing the activities. This may be due to a combination of degradation of motivation, cognitive and physical abilities as students are spending most of their time in surfing mobiles for other activities like social networking rather than for wellness and health and thus do not use smart phones and mhealth fitness applications as much and as effectively and efficiently as peoples, such as the trainers who were tested do. Its worth to mention that during usability test, the author has also observed the importance of problems which occurred while using the application was not perceived in the same way by trainers and students. To strengthen the argument, trainers stressed the importance of colors, but the students gave a suggestion to make the colors more attractive, if the application is for trainers, although most of them were comfortable with the present color. Ultimately, it shows that there is a difference in opinions of the usability issues encountered in mHealth applications between different groups, when people who differ in profession use it.
5.6 Usability test findings

In this section, the author will discuss about gathered observations from all the participants. From the observations of the usability test, the author has noticed where the end users (trainers/students) may experience difficulty while using the application. Observations showed that the participants were not able to explore the structure of the application. As some of the participants were students, so they often complained about the color. Although some participants were satisfied with the color, and other participants felt that the color was not distinguishable. In the reports tab of the application, participants were not able to perceive all the details about the fitness graphs. The fitness graphs are illustrated using different colors which made some of the participants surprised what these different colors represent. But its worth to mention that all the participants were satisfied with wordings and spacing of the text fields. Participants were not able to differentiate between layout and icons and feeling not convenient with the background color of the application as they seem to amalgamated with the interactive icons on the screen.

5.7 Questionnaire

Questionnaires deliver what is required, in this case and when it comes to collect quantitative data. It is the result of questionnaire and data obtained from it will represent the strengths and weakness and at the same time participants responses and their expectations while interacting with mHealth wellness application [29]. The data collected through questionnaire was analyzed through statistical analysis. On the basis of the Nielsen’ five proposed quality components the observed results were classified. Furthermore, to evaluate the application, the questionnaire was prepared in such a way that it was answered according to the five quality components. This questionnaire can be answered by the peoples who used the application. Therefore, it was answered by the participants who have participated in the usability test. The questionnaire was prepared using google forms. Likert scale was adopted such that each question was answered along a scale from strongly disagree to strongly agree.

5.7.1 Questionnaire results

Its worth to mention that, the author has disposed/prepared a questionnaire for the participants in the usability test. The main purpose of this questionnaire is to evaluate the mobile wellness application and hence it also serves the purpose of validation. Below table 6 shows the results gathered from trainers and students. For the categorical questions in the questionnaire, see appendix A.

<table>
<thead>
<tr>
<th>Usability attributes</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learnability</td>
<td>7.50%</td>
<td>10.00%</td>
<td>12.50%</td>
<td>37.50%</td>
<td>32.50%</td>
</tr>
<tr>
<td>Efficiency</td>
<td>10.83%</td>
<td>14.17%</td>
<td>23.33%</td>
<td>24.17%</td>
<td>27.05%</td>
</tr>
<tr>
<td>Memorability</td>
<td>15.00%</td>
<td>12.50%</td>
<td>12.50%</td>
<td>25.00%</td>
<td>35.00%</td>
</tr>
<tr>
<td>Error rate</td>
<td>17.50%</td>
<td>17.50%</td>
<td>15.00%</td>
<td>20.00%</td>
<td>30.00%</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>6.67%</td>
<td>11.67%</td>
<td>16.67%</td>
<td>28.33%</td>
<td>35.00%</td>
</tr>
</tbody>
</table>
For learnability, about 32.50% of the participants strongly agree that the application is easy to learn and it is reliable, whereas, 37.50% participants have ranked it as agree and 12.50% have ranked it as neutral. 10.00% and 7.50% has shown their disagreement and strongly disagreement respectively.

For efficiency, 27.05% of the participants strongly agree that the interface is somehow attractive and they can understand the application easily whereas, 24.17% participants have ranked it as agree and 23.33% have ranked it as neutral and similarly 14.17% and 10.83% has shown their disagreement and strongly disagreement.

For memorability, 35.00% of the participants have strongly agree that they are able to remember the application once they have used it, whereas, 25.00% have ranked it as agree and 12.50% neutral and also worth to mention that 12.50% has shown disagreement and 15.00% strongly disagree.

For error rate, 30.00% of the participants have strongly agree that the application provides assistance when an error occurs where as 20.00% have ranked it as agree and 15.00% have ranked it as neutral.17.50% disagree and 17.50% strongly disagree.

For satisfaction, 35.00% of the participants have strongly agreed that application provides satisfaction regarding the interface and functionalities whereas, 28.33% have ranked it as agree and 16.67% have ranked it as neutral and 11.67% disagree and 6.67% strongly disagree.

The above figure 3 shows an overall user response of the participants (Trainers and students) from the questionnaire. It can be observed that the participants overall were satisfied with the current interface. Its important to mention that, no one of the participants has strongly disagreed with the present interface and performance of the application. However, if efficiency and satisfaction is considered then it seems a little bit fluctuating. The reason for not strongly agreeing is explained in chapter 6, Section 6.1, Discussion.
5.7.2 Questionnaire analysis

Graphs are generated from the obtained results to show the mean statistical data obtained from questionnaires. Figure 4, 5, 6, 7 and 8 respectively shows the comparison of responses from both the trainers and students on the questionnaire. During the course of time when each quality component was observed in both graphs, it can be noticed that there were some differences between them. To discuss the differences that is observed by the author by considering each component, below section will highlight them in detail.

While looking at the graphs of trainers and students and assessing each usability attributes, it can be observed that a minor difference occurs in the level of agreement on the questionnaire. This was made clear as being primarily due to their professions and lack of interests and knowledge on how to use the mHealth wellness application.

When learnability was contemplated, it was observed that some of the students have difficulty in understanding the application and they felt that it was not easy to learn and therefore this variation is made obvious in the fact that students tend to agree but not strongly agree as shown in figure 4.

![Learnibility Graph](image)

**Figure 4 Mean value of learnability between trainers and students**

When the second functionality component i.e. efficiency was considered, it can be observed from figure 5 that students have more often prefer for disagreement when compare to trainers. This appear to be mainly due to the navigational structure because the students had problem in understanding it. They were usually confused when performing the activities. Lack of interpretation of data in the report was another problem that led to the selection of disagreement or neutral.
When memorability was examined, students have selected agree but trainers have selected strongly agree as can be seen on figure 6. The author has interpreted this as being mainly due to lack of motivation, cognitive and physical abilities. Though the amount of acquired experienced, skill and proficiency with using the mHealth wellness applications is more with trainers as compared to students and hence it plays a role here. Since there was no assistance provided for the application. However, it was ensured that guidelines can provide guidance if the participants want to review them again.

When error rate was examined, trainers have entertained themselves more with the application when compared with students as obvious in figure 7. While playing with the mHealth wellness app, trainers mainly focused on the activities rather than on errors, whereas students have observed the errors when performing the activities and thus it led to the difference in the level of agreement between trainers and students.
When satisfaction was considered as functionality component, the trainers seem to have much more experience in using mobile wellness applications than the students who participated in the test and this is apparently the reason why most of the trainers were satisfied with the mobile health application as shown in figure 8. Its worth to mention that during usability test, the student participants have specified that the activio application was useful. But suggested that if there were some more functionalities they would be more satisfied. Both trainers and students agreed that these type of applications have the potential to improve the quality of life when it comes to fitness and wellbeing. Further, some suggestions and recommendations for improvement has also been provided which would result in that they would be satisfied with the application.
5.8 Interview Results

This section presents about the results and analysis of the interviews conducted with user experience designers and developers to know how usability issues are considered in the design and development of mHealth wellness application. Six interviews were conducted with six different participants where four belongs to the same organization and the other two belongs to different organization. Its worth to mention that, all these participants have a hand on experience in user experience design and have established a reputation as user experience designers in their respective organizations. Mostly, the interviews were conducted face to face and anonymity of the interviewee was promised and therefore audio recording was used during the conversations. The RQ3, “What suggestions of improvements based on the identified usability issues and requirements and motivational aspects in mHealth wellness apps can be made for improved/future technology?” was the main question that was asked in the interviews, and a few extemporaneous open ended questions were also asked in interview during the middle of conversation.

5.8.1 Overview of interview

To gather information regarding suggestions of improvements based on the identified usability issues, requirements and motivational aspects in mHealth wellness apps, the following interviews were conducted as shown in table 7:

<table>
<thead>
<tr>
<th>ID</th>
<th>Interviews date</th>
<th>Experience</th>
<th>Time spent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4th April, 2016</td>
<td>7</td>
<td>17 min</td>
</tr>
<tr>
<td>2</td>
<td>8th April, 2016</td>
<td>5</td>
<td>24 min</td>
</tr>
<tr>
<td>3</td>
<td>12th April, 2016</td>
<td>9</td>
<td>26 min</td>
</tr>
<tr>
<td>4</td>
<td>18th April, 2016</td>
<td>6</td>
<td>17 min</td>
</tr>
<tr>
<td>5</td>
<td>22th April, 2016</td>
<td>8</td>
<td>20 min</td>
</tr>
<tr>
<td>6</td>
<td>29th April, 2016</td>
<td>10</td>
<td>23 min</td>
</tr>
</tbody>
</table>

5.8.2 Interview analysis

Data obtained from the interviews were analyzed by using thematic analysis. Thematic analysis (TA) is a method for determining, analyzing and narrating patterns (themes) within the data [44]. The purpose is to organize and describes data set minimally and in detail. However, if goes further than this interprets various aspects of the research topic. Therefore, the author focused on the main theme i.e. suggestions of improvements based on the identified usability issues and requirements and motivational aspects in mHealth wellness applications. So the author has generated codes under this theme. The following phases are carried out in thematic analysis:

- Familiarizing with your data
- Generating initial codes
- Searching for themes
- Reviewing themes
- Defining and naming the themes
- Producing the report

Initially the author has organized the acquired information from the interviews and analyzed it. Based on this analysis, the author has reproduced
codes from the acquired information in such fashion that the codes fall under the theme strategy. The codes helped the author in analyzing the information. Therefore, the codes generated in the interview under the theme strategy were.

- User centered design
- Ease of use
- Satisfaction
- Activity centered design
- Motivation and long term use
- Navigation structure

5.8.3 Analysis of responses given to questions about suggestions of usability improvements

When questions were asked by the author, among 6 respondents, 3 of them have said that the foremost thing that came to mind were two approaches.

- User centered design
- Ease of use

Therefore, based on the application domain, target user groups and ease of use of mobile application. One approach was chosen among the three. When the author notified that the focus of the study was about the mHealth wellness applications. User centered design along with motivation and long term use was stated as being preferred by all the interviewees. The reason for this preference was given that end users plays an important role in mhealth wellness applications. Therefore, bringing end users into the design process, they will be able to engage in the design process. Hence the assumptions made by the designers can be omitted and the real need of the users can be identified. In addition, most peoples have set certain goals in fitness and the apps help in particular to acquire those goals. By doing so it will ensure a healthy competition and bring some better results. In addition, two out the four different methods that are used in user centered design such as, Participatory design, Questionnaires, Focus groups, Usability testing and Interviews. Usability testing and Focus groups were the most common methods. They also mentioned that participatory design is also among the best approaches. It is through this process that the stakeholder gets involved in the design process which makes the required application more usable. Here both respondents have mentioned that they should consider the end user i.e. students in this case as one of the stakeholders. The respondents were of the view that participatory design can give effective results regarding the mobile application for fitness.

The other three respondents have mentioned that suggestions for improved usability is to involve the end users in the design process. In addition, to the previous one for improving the usability, some points have also been mentioned when the mHealth wellness application is for students. One of the explanation given was most of the students lack interest with the passage of time. So, developers should design the interface in such away as to motivate the users by behaviors and provide the application with ease of use. Its worth to mention about an explanation given by another interviewee that users should be facilitated by the necessary help whenever they need it and therefore the application must be constructed in a way to be fully supportive and therefore accomplish the tasks in an efficient way.
CHAPTER 6: DISCUSSION AND VALIDATION

This chapter relates to the discussion and validation of the analysis done in this thesis. Section 6.1 describes in detail about the discussion followed by usability quality components. Section 6.2 describes the validity and reliability of results. Furthermore, answers to the research questions are also provided in Section 6.3.

6.1 Discussion

The purpose of this thesis was to analyze the usability issues that occur in a mHealth wellness application for fitness. And the target selected for this study was trainers and students. For this purpose, the author selected a mHealth wellness application namely ‘Activio APP V.1.0’ from the ‘Activio AB’ company. The author used a systematic approach to assess the application and identify the usability issues encountered while using the application.

6.1.1 Usability quality components

From the literature study, the author has selected usability principles and has carried out usability tests and therefore gathered feedback based on the selected usability principles.

6.1.1.1 Learnability and Memorability

The author observed while performing the activities that there seems fluctuations in the completion time by the participants. Therefore, the users should be able to learn the procedures in such a way to ensure the smooth use of application. However, its worth to mention that most of the users were able to learn and memorize the application once used. 14 participants have recommended an instruction based on motivation or a video application to clinch the features of the application when the users intends to use the application for the first time.

6.1.1.2 Efficiency

While using the application, most of the participants were able to do surfing easily and find the required options while performing the activities. So navigating on the pages was efficient but some time they took more steps to perform the task than the ideal steps. Their ultimate affect was on the time to achieve the task. The author observed that font color also had an effect on the participants. Participants experienced troubles when finding the guidelines for the reading the report. They were not able to recognize the report and most of the participants have suggested to make it bigger or change the color. When they switched to reports page, the participants were confused about which color represents what. Therefore, participants suggested to explain about the visualization of color.

6.1.1.3 Error rate

While doing registration, most of the participants have reported errors when they partially filled the text field and shows a red star at the top of the text field. To strengthen the argument, for an input field for entering an email account if it is partially completed and if next is pressed by the user than it does not show the type of the error but it highlights the text field with a red star at the extreme left of the text field.
6.1.1.4 Satisfaction

An overall satisfaction was shown by the participants when they come across the application. However, it will be added to mention that the representation of colors in the reports has distracted some participants regarding what it represents. Eliminating the color representation issue, the participants felt satisfied from the structure of the mobile application stating simple and not complicated and is easy to use.

6.2 Validity discussion

In quantitative research, an activity or piece of work is said to be valid or true if it represents precisely the intended characteristics of its nature, a guideline is used to validate the results, and it includes credibility, dependability, transferability and confirmability [45]. The author has followed a mixed approach. When using this approach, it is essential to validate the results. The main part of the research is done through a qualitative approach according to the theoretical work and usability test conducted on the trainers and students. The following subsections describes these criteria in details:

6.2.1 Credibility

Credibility refers to the acceptance of the results from the view point of the participants [45]. The result should be reasonable by the participants; thus the credibility of the research can be judged by the participants' themselves. Figure 3 in section 5.7 showed that all participants were satisfied with the wellness application. To ensure that the results obtained from the usability test can be trusted, the author has conducted a survey using a questionnaire. Further, results from the interviews can be trusted as they were conducted from experienced user experience designers.

6.2.2 Dependability

Dependability refers to the fact that the findings can be repeated and they are consistent in nature [45]. In this thesis the author targets the trainers but due to insufficient resources, the author conducted the initial usability test with BTH students. Later, this issue was addressed by conducting another usability test with the trainers. This provided the opportunity to compare results between the first group with students and the second group with the trainers. clear differences were shown between the groups regarding what and how usability issues were perceived further how they affect the error rate and therefore the time it requires to accomplish the activities during usability test.

6.2.3 Transferability

Transferability refers to the fact that the findings obtained from the research are applicable in other contexts [45]. In this thesis, the selected mobile wellness application is similar to many other mobile applications. Though the results achieved from this research is based on interface, therefore they can be related to many other mobile applications.

6.2.4 Confirmability

Confirmability refers to the extent to which the results from the research study could be confirmed by others [45]. Therefore, the findings from the research are the results of the participants’ preferences, motivation or interests
rather than that of the researchers. In this particular case of thesis work, the results of the usability tests conducted can be differ from different participants. Therefore, to ensure the results obtained did not change the author performed the tests on the same same group. Because, different results were expected if change occurs in context of use.

6.3 Research questions answers

**RQ1:** During mobile health application development, what role does usability evaluation and considerations concerning design for motivation play?

It is through usability evaluation approach that users understand and make them able to use an application and ensuring the users further to perform some specific activities or a group of activities under certain conditions. To justify this argument and answer the research question, a literature review has been conducted by the author on how motivation with respect to usability evaluation assists in development of wellness application. Because it is through usability evaluation that helps in understanding the users and their respective expectations about mobile applications. Chapter 4, sections 4.2 and 4.3 has shown the theoretical work.

**RQ2:** What issues concerning usability were involved when studying/developing a mHealth application for fitness by keeping the user satisfaction and motivation mind?

Usability test was conducted by the author to analyze and identify the usability issues. At the start of the study the author was initially faced by a genuine limitation, i.e. the author has since initially not able to get trainers to perform the test and therefore the test was conducted on students. But this issue has been latterly addressed when an additional usability test was performed with ten trainers. The author analyzed the motivation and behavior of users based on satisfaction through observation of activities they performed. The author also conducted interviews and informal discussions for analyzing the views of the participants. A questionnaire was answered by the participants which was designed in such a way that it supplements to results of the usability evaluation in the context of Nielsen’s usability quality attributes. Chapter 5 details about the usability test and their results.

**RQ3:** What suggestions of improvements based on the identified usability issues and requirements and motivational aspects in mHealth apps can be made for improved/future technology?

Section 5.8 presents the analysis of interview results in details. Inspection has been done when strategies being applied in design and development practice to improve the usability of mHealth wellness applications. It was concluded based on the respondent’s response that the use of participatory design methods yields in constructing a consistent application with simple navigational structure and has the capability to handle errors are some of the strategies that will provide efficient results regarding usability when it comes to motivation and behavior in mobile health application for fitness.
CHAPTER 7: CONCLUSION AND FUTURE WORK

This chapter presents conclusion and suggestions. Furthermore, the proposed extension of this thesis work is also discussed in Section 7.3.

7.1 Conclusion

The leading objective of this thesis is to determine and inspect usability problems in relation to motivation that occur in the selected mHealth wellness application i.e. ‘Activio’. The first step that carried out was of literature review in order to gain an insight knowledge about the usability evaluation methods and to find related research work. In the second step, the author selected 20 participants (10 trainers and 10 students) from lok and motion fitness club karlskrona and BTH respectively. Its worth to mention that 4 of them i.e. (2 trainers and 2 students) were selected for a pre-test. The author has tried to arrange a natural environment in a space provided by lok and motion fitness gym and hence usability test was conducted with the participants individually. It was through the findings from literature review and usability testing that ultimately helps the author in designing the questionnaires. The questionnaire was dispensed by creating a google form for trainers and students who have participated in the usability test and the author has validated the results with the help of questionnaire. Furthermore, the questionnaire also helped the author to identify the level of participants’ subjective satisfaction and motivation for continue use over time. When the participants interacted with the user interface of the mHealth wellness application and resulted in a mapping of the usability problems. As a result, the observed usability problems provide input for the recommendations and suggestions which will be helpful in designing effective and efficient mHealth wellness application in the future. Efficient mobile application will advantage in ideally supporting and enhancing effective communication between trainers and trainees and will make a contribution in transforming physical fitness into a more ingenious mHealth fitness solutions.

7.2 Suggestions

Based on the recommendations derived from observations by the participants from the usability test, the author has come up with some suggestions for the mobile application used in fitness. Its worth to mention that the overall performance of the application was satisfying but some modifications were suggested to enhance the application for efficient and effective use.

Presently, the tested mobile application does not have a walkthrough or a video of how it works for the ordinary peoples in our case students. Therefore, the available functionalities and terminology usage can be including in such away to avoid frustration of the said users. Further more, observations show that participants were not able to understand the navigational structure when they switched from one page to another and hence loose interests. Therefore, to mitigate this issue videos and games can be incorporated in such a way that the users from all walk of life gets motivated and starts using and continue user over time.

Observations reveals that at some point the users were not able to differentiate the background and help icon in the interface. Icons of brighter colors seems to attract the trainers in specific but loose the grasp to attract the
students. Therefore, colors must be integrated in such away to differentiate from the background for all users.

Personalization option for language and font size is also desirable. Because in fitness center, I have the experience of observing elder peoples doing their fitness. So by including this option, users can choose the desired size of the font and therefore will increase the visibility of the contents in the application. English language is widely accepted, but users opt to use their regional language. As this mobile health wellness application is in English and if there is a personalization option for Swedish language then it would improve the readability and accessibility of the application for the elder peoples in particular and the regional public in general.

7.3 Future work

The personalization option for language and font size is also desirable. Because in fitness center, I have the experience of observing elder peoples doing their fitness. So by including this option, users can choose the desired size of the font and therefore will increase the visibility of the contents in the application. English language is widely accepted, but users opt to use their regional language. As this mobile health wellness application is in English and if there is a personalization option for Swedish language then it would improve the readability and accessibility of the application for the elder peoples in particular and the regional public in general.
REFERENCES


[23] M. Kamana, “Investigating usability issues of mHealth apps for elderly people.”


## 6.4 APPENDIX A

<table>
<thead>
<tr>
<th>No</th>
<th>Questions</th>
<th>Disagree</th>
<th>Agreement level</th>
<th>Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Learnability</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Data grouping is reasonable for learning.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Touch screen is reacting well and app is reliable.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Efficiency</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>The application simple and user friendly.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Learner or expert can understand the application.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Interface is easy to use and attractive.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Navigational arrangement is simple and information is centralized for the users.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Moving between screen is accurate and uninterrupted.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>I am able to derive information I need from the report.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Memorability</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Easy to remember.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Once used any need of guidance.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Error rate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Application notifies in case of errors.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Display and ability to determine erroneous entries.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Satisfaction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Feedback on the application is satisfied.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Application benefits in improving the quality of life.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Present functionalities provides satisfaction.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.5 APPENDIX B: SCREENSHOTS OF ACTIVIO APP

SCREENSHOT1: ACTIVIO APP
SCREENSHOT 2: HEART RATE TRAINING

SCREENSHOT 3: MY ACTIVIO LOGIN
SCREENSHOT 4: ACTIVIO WORKOUT

SCREENSHOT 5: CLASS PROFILES
SCREENSHOT 6: WORK OUT WITH ACTIVIO

SCREENSHOT 7: FIND MAXIMUM HR