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Improvements of a First Aid Application Based on a Usability Study

Diploma Thesis

submitted by

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Abstract

Millions of applications for smartphones exist and are gaining popularity since the introduction of smartphones in 2005. But, merely a small number of these applications (apps) were developed in support of first aid. Such type of app might be important and helpful when witnessing an emergency situation.

This paper consists of the observation of existing first aid applications for smartphones and comparing them to a first aid application developed by the University of Koblenz called “Defi Now!”. The main focus lies on examining “Defi Now!” in respect to its usability based on the dialogue principles referring to the seven software ergonomic principles due to the ISO 9241-10 standard. These are known as suitability for learning, controllability, error tolerance, self-descriptiveness, conformity with user expectations, suitability for the task, and suitability for individualization.

Therefore a usability study was conducted with 74 participants. A questionnaire was developed, which was to be filled out by the test participants anonymously. The results were captured by video and documented by text, in order to gain reliable data on the advantages and disadvantages of such a first aid application.

Content

1. Introduction and Motivation

When suffering from cardiac arrest immediate help is essential and a defibrillation is mostly inevitable. The chance of survival decreases 10% by the minute when no help is provided (Cummins et al., 1985). Hence, everybody who owns a feature phone or smartphone is able and obliged to call for help on site.

Newly presented statistics show an increase of smartphones on the consumer market (Figure 1). Out of the millions of smartphone applications (apps) that already exist, only few were developed in light of first aid (Figure 2). These first aid apps might be able to ensure passersby when witnessing an emergency by encouraging them to administer first aid and thus minimizing the *bystander-effect* (Bibb Latané, 1968).

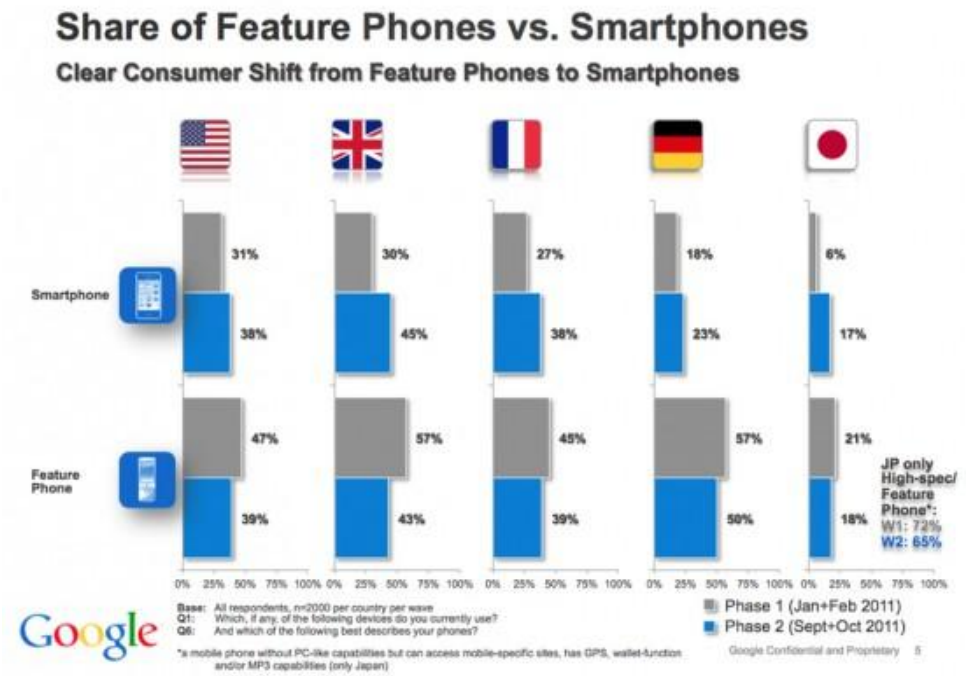


Figure 1 Smartphone Ownership

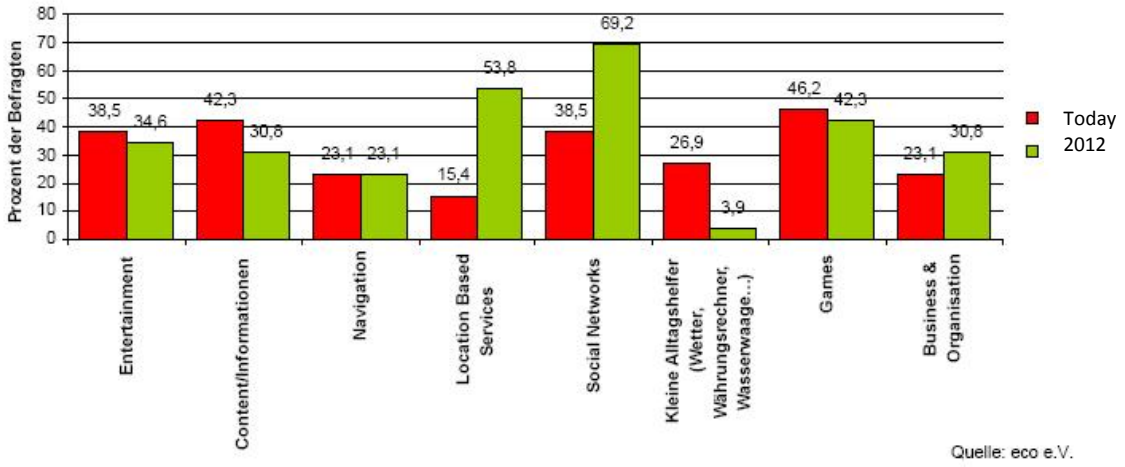


Figure 2 Distribution of Smartphone Applications

The phrase “bystander-effect” defined by Latané and Darley (1968) characterizes the phenomenon that individuals are less willing to offer help the more bystanders are present in case of an emergency. This diffusion of responsibility results in waiting for someone else to assume control. Further, bystanders tend to belittle the existing emergency since no one has intervened so far. Thus, in their opinion, an emergency can be excluded and no help is necessary. The most common cause for the denial of assistance however might be the fear to fail or of humiliation. This fear detains many people to help, especially in situations that they are unable to judge (Jörg, 2012).

Sudden cardiac arrest due to ischemic heart disease is the most common cause of death in most Western countries and a major cause of hospital admissions. For instance Germany recorded 127.101 deaths in 2011 because of ischemic heart disease; in the U.S. the number of deaths due to Sudden Cardiac Death even exceeds 250,000 annually (Stefanos Archontakis, 2010) (Figure 3). The Figures 4 and 5 reveal the distribution of ischemic heart diseases among men and women, showing no significant differentiation between the genders. (The Information System of the Federal Health Monitoring, 2011)

European Shortlist	Figure		
	Deaths	Deaths per 100,000 inhabitants	Deaths per 100,000 inhabitants (age-standardised)
Diseases, injuries and poisoning	852,328	1,042.2	721.4
Infectious and parasitic diseases	16,683	20.4	14.2
Neoplasms	228,220	279.1	208.9
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	2,683	3.3	2.3
Endocrine, nutritional and metabolic diseases	29,822	36.5	24.6
Mental and behavioural disorders	27,113	33.2	21.2
Diseases of the nervous system and the sense organs	22,731	27.8	19.9
Diseases of the circulatory system	342,233	418.5	268.3
Ischaemic heart diseases	127,101	155.4	102.7
Other heart diseases	78,225	95.7	58.9
Cerebrovascular diseases	59,066	72.2	46.8
Diseases of the respiratory system	60,019	73.4	50.0
Diseases of the digestive system	40,507	49.5	35.8
Diseases of the skin and subcutaneous tissue	1,161	1.4	0.9
Diseases of the musculoskeletal system and connective tissue	3,056	3.7	2.6
Diseases of the genitourinary system	19,667	24.0	15.4
Complications of pregnancy, childbirth and puerperium	X	X	X
Certain conditions originating in the perinatal period	1,244	1.5	2.0
Congenital malformations and chromosomal abnormalities	1,619	2.0	2.2
Symptoms, signs, abnormal findings, ill-defined causes	22,550	27.6	20.4
External causes of injury and poisoning	32,988	40.3	32.6

Figure 3 Mortality Figures According to the European Shortlist 2011

European Shortlist	Figure		
	Deaths	Deaths per 100,000 inhabitants	Deaths per 100,000 inhabitants (age-standardised)
Diseases, injuries and poisoning	444,700	1,068.3	743.6
Infectious and parasitic diseases	9,133	21.9	15.6
Neoplasms	105,421	253.3	203.0
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	1,617	3.9	2.8
Endocrine, nutritional and metabolic diseases	17,435	41.9	28.5
Mental and behavioural disorders	16,117	38.7	23.7
Diseases of the nervous system and the sense organs	11,973	28.8	21.2
Diseases of the circulatory system	196,678	472.5	300.0
Ischaemic heart diseases	62,290	149.6	96.7
Other heart diseases	48,900	117.5	71.6
Cerebrovascular diseases	36,025	86.5	56.8
Diseases of the respiratory system	27,988	67.2	46.9
Diseases of the digestive system	19,959	47.9	34.9
Diseases of the skin and subcutaneous tissue	780	1.9	1.3
Diseases of the musculoskeletal system and connective tissue	2,019	4.9	3.5
Diseases of the genitourinary system	11,259	27.0	17.8
Complications of pregnancy, childbirth and puerperium	32	0.1	0.1
Certain conditions originating in the perinatal period	547	1.3	1.7
Congenital malformations and chromosomal abnormalities	760	1.8	2.0
Symptoms, signs, abnormal findings, ill-defined causes	10,218	24.5	17.5
External causes of injury and poisoning	12,764	30.7	23.2

Figure 4 Mortality Figures (Women) According to the European Shortlist 2011

European Shortlist	Figure		
	Deaths	Deaths per 100,000 inhabitants	Deaths per 100,000 inhabitants (age-standardised)
⊖ Diseases, injuries and poisoning	407,628	1,015.2	650.9
⊕ Infectious and parasitic diseases	7,550	18.8	12.1
⊕ Neoplasms	122,799	305.8	198.8
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	1,066	2.7	1.7
⊕ Endocrine, nutritional and metabolic diseases	12,387	30.8	19.5
⊕ Mental and behavioural disorders	10,996	27.4	18.0
⊕ Diseases of the nervous system and the sense organs	10,758	26.8	17.5
⊖ Diseases of the circulatory system	145,555	362.5	218.2
Ischaemic heart diseases	64,811	161.4	98.7
Other heart diseases	29,325	73.0	43.1
Cerebrovascular diseases	23,041	57.4	34.3
⊕ Diseases of the respiratory system	32,031	79.8	48.0
⊕ Diseases of the digestive system	20,548	51.2	34.8
Diseases of the skin and subcutaneous tissue	381	0.9	0.6
⊕ Diseases of the musculoskeletal system and connective tissue	1,037	2.6	1.7
⊕ Diseases of the genitourinary system	8,408	20.9	12.1
Complications of pregnancy, childbirth and puerperium	X	X	X
Certain conditions originating in the perinatal period	697	1.7	2.3
⊕ Congenital malformations and chromosomal abnormalities	859	2.1	2.5
⊕ Symptoms, signs, abnormal findings, ill-defined causes	12,332	30.7	22.2
⊕ External causes of injury and poisoning	20,224	50.4	41.0

Figure 5 Mortality Figures (Men) According to the European Shortlist 2011

With respect to these arguments Thomas Lange from the University of Koblenz has developed a first aid application as guidance during an emergency such as cardiac arrest (see section 3.6) as his diploma thesis in 2011. This application was tested and evaluated in line of a usability study regarding its usability (see section 10). Further it was improved (see section 11) based on the yielded test results and software ergonomic principles (see section 6).

Throughout the survey the assumption was manifested that a vast majority of people is not acquainted with first aid regarding sudden cardiac arrest. Although most of them approximately know how to perform CPR, they still are insecure about the resuscitation beat. Further a rather shocking result was yielded during the survey. When a group of possible testees was asked whether they want to participate in the usability study they declined, stating they are well acquainted with first aid. Questioning them further in respect of an “AED”, they asked what an “AED” is. After explaining the mechanisms of an AED, one of them pointed out to a device hanging on an isolated column and asked if that is a so-called “AED”. This had to be denied because the device hanging on the wall was a fire extinguisher. This anecdote seems to be amusing at first, but the person who confused a fire extinguisher with an automated external defibrillator, was dead serious and in no sense was able to recognize an AED respectively knew what this device is used for.

Another story told by a participant who is a doctor working in a hospital, is nearly as alarming. In an unpublished survey, the staff of the hospital was instructed not to intervene or even to have left the entry before a person, simulating a sudden cardiac arrest, collapsed in the main hall. It was observed that several people tried to help and even wanted to administer CPR. None of them though noticed or recognized the AED hanging on a wall, one meter above the collapsed person. If this simulation had been real the person suffering from a cardiac arrest might have passed, although the possibly life-saving device was mounted within reach, and the defibrillation could have been started within one minute, offering the victim a high survival rate.

These two anecdotes show how necessary the enlightenment of the public regarding emergencies such as cardiac arrest is. First aid applications as “Defi Now!” might provide support to correct handling in those emergency situations.

2. The Human Heart

To supply better understanding, the following sections comprise the human heart whereas it is discussed in its structure and functionality as well as possible occurring coronary heart diseases (see section 3) which might lead to cardiac arrest. In addition, cardiopulmonary resuscitation (CPR) will be described (see section 4). Further the utilization and functionality of automated external defibrillators (AEDs) is introduced in section 5.

2.1. The Structure of the Human Heart

The human heart is one of the most vital organs in the human body. It provides a continuous blood circulation through the cardiac cycle by contracting rhythmically.
The human heart weighs between 250 and 350 grams and is about the size of a fist. It is enclosed in a protective sac called the pericardium, which consists of the *pericardial fluid*. The main tasks of this fluid are nourishing the heart and preventing it from shocks. (National Heart, Lung and Blood Institute)

The outer wall of the heart is composed of three layers. The outer layer, the *epicardium* or *visceral pericardium* is also the inner layer of the *pericardium*. The middle layer of the heart, the *myocardium*, consists of a muscle which contracts. The inner layer, called the *endocardium*, merges the inner lining of blood vessels and covers heart valves. This third layer is also in contact with the blood that the heart pumps.

The heart consists of four chambers: two upper chambers (*left and right atrium*) and two lower chambers (*left and right ventricles*). The atria are the receiving chambers and the ventricles are the discharging chambers. Therefore one side of the heart houses one atrium and one ventricle. These two are connected by a valve. (Texas Heart Institute)

Four types of valves regulate the blood flow through the human body.

- The *pulmonary valve* controls blood flow from the right ventricle into the pulmonary arteries, which carry blood to the lungs to pick up oxygen.
- The *tricuspid valve* regulates blood flow between the right atrium and right ventricle.
- The *mitral valve* lets oxygen-rich blood from the lungs pass from the left atrium into the left ventricle.
- The *aortic valve* opens the way for oxygen-rich blood to pass from the left ventricle into the aorta, the body's largest artery, where it is delivered to the rest of the body.

Both sides of the heart are separated by a thick wall of muscle called the *septum*. On both sides the lower ventricles are thicker than the upper atria. Still, the left ventricle is the largest and strongest chamber in the human heart. The surrounding left ventricle's chamber muscle walls are only about a half-inch thick, but they have enough force to push blood through the aortic valve and into the body (Figure 6). (The Franklin Institute)

The top of the human heart is connected to a few blood vessels. The largest one of them is called *aorta*, also known as the main artery. Through the aorta, nutrient-rich blood is carried away from the heart. The second important vessel is the *pulmonary artery*, which is, by connecting the heart to the lungs, a part of the pulmonary circulation system.

The two largest veins that carry blood into the heart are called the *inferior vena cava* and the *superior vena cava*. The term “Vena cava” stems from the fact that these veins are the “heart’s veins”. The superior vein is located near the heart’s top and the inferior lies beneath the superior. (Texas Heart Institute)

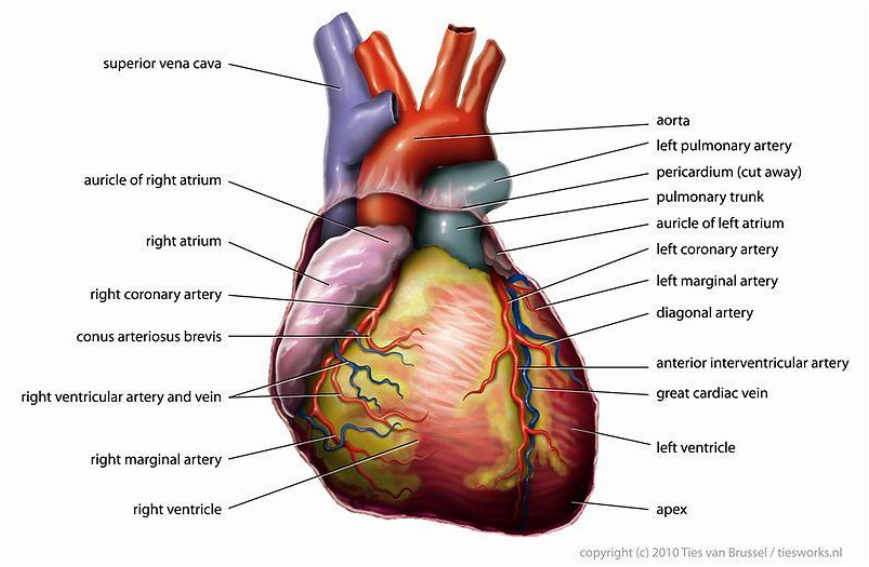


Figure 6 The Human Heart

2.2. Functioning of the Human Heart

Besides outlining the structure of the human heart, an overview of the main function shall be given here and more specifically as the “cardiac cycle” in section 2.3. The human heart functions as a double pump. The right side of the heart acts as a collector for de-oxygenated blood, which flows to the right atrium from the body via superior and inferior vena cava. The blood is then pumped via the right ventricle into the lungs so that gas exchange can take place. Carbon dioxide can be dropped off and the blood gets enriched with oxygen.

The left side of the heart collects the oxygen-rich blood from the lungs and pumps it into the left atrium. From there the blood is carried to the left ventricle which transports it via the aorta into the body (Figure 7). (Texas Heart Institute)

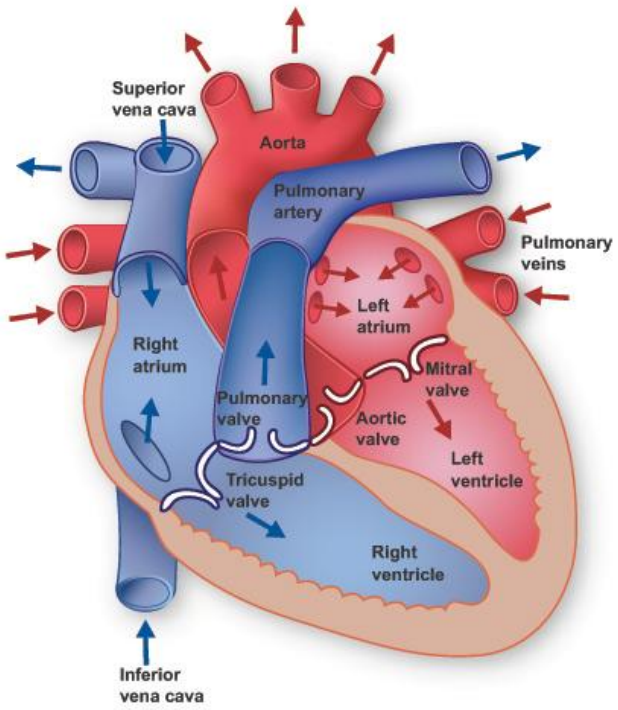


Figure 7 Blood Flow

2.3. The Cardiac Cycle

Describing the process of the cardiac cycle more specific, blood is carried from the right atrium through the tricuspid valve to the right ventricle. From here it is pumped out of the pulmonary semilunar valve and is transported via the pulmonary artery to the lungs where the previous described gas exchange takes place (Figure 7). (Maton & Roshan L. Jean Hopkins 1993)

At this point, oxygenated blood flows back through the pulmonary vein to the left atrium. Via the mitral valve, blood is carried to the left ventricle, from where it is pumped through the aortic semilunar valve to the aorta and to the rest of the body.
Completing the cardiac cycle, the relatively deoxygenated blood returns to the heart via the inferior and the superior vena cava and enters the right atrium, where the cycle began.

During the contraction of the heart healthy valves open and close in the exact coordination with the pumping action of the atria and ventricles. Each valve has a set of flaps called cusps or leaflets that open or close a valve. This mechanism allows blood to flow into the chambers and arteries without flowing backward.

2.4. Conduction System of the Human Heart

The sinoatrial node (SA node), also known as the primary pacemaker of the human heart, is a muscular and macroscopic poor definable tissue where electric energy that stimulates the organ occurs. It produces a definite potential and then discharges, sending an impulse across the atria approximately once per second. There the signal moves from cell to cell, while in the ventricles the signal is carried by the Purkinje fibers, a specialized tissue which transmits the electric charge to the myocardium. With this process the contraction of the heart is initiated (Figure 8). (National Heart, Lung and Blood Institute)

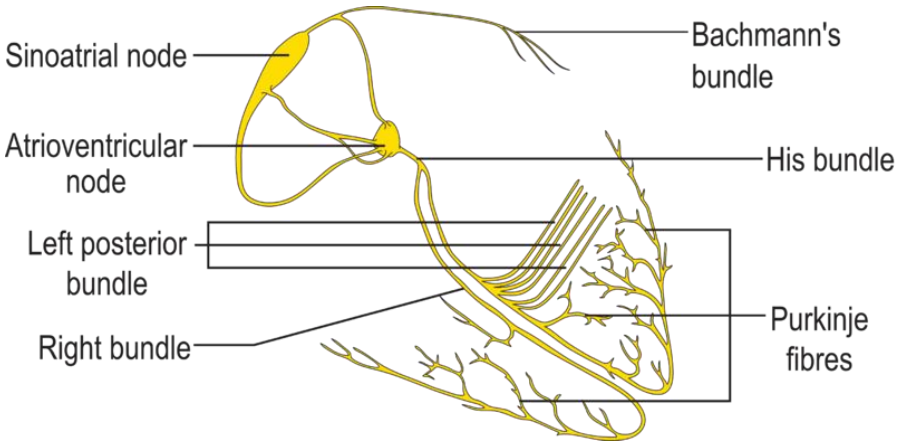


Figure 8 Sinoatrial Node

A wave of excitation spreads out from the sinoatrial node through the atria along specialized conduction channels. An impulse that originates from the SA node at a 60-100 beats per minute, and when under no physical strain, is called normal sinus rhythm. One single sinus rhythm, as can be seen on the ECG (electrocardiography), displays the in section 2.3 mentioned stages of the cardiac cycle (Figure 9). (Principle of ECG formation, 2005)
If SA nodal impulses occur at a rate less than 60bpm, the heart rhythm is known as *bradycardiac sinus*. If it occurs with a rate greater than 100bpm, it is called *tachycardiac sinus*.

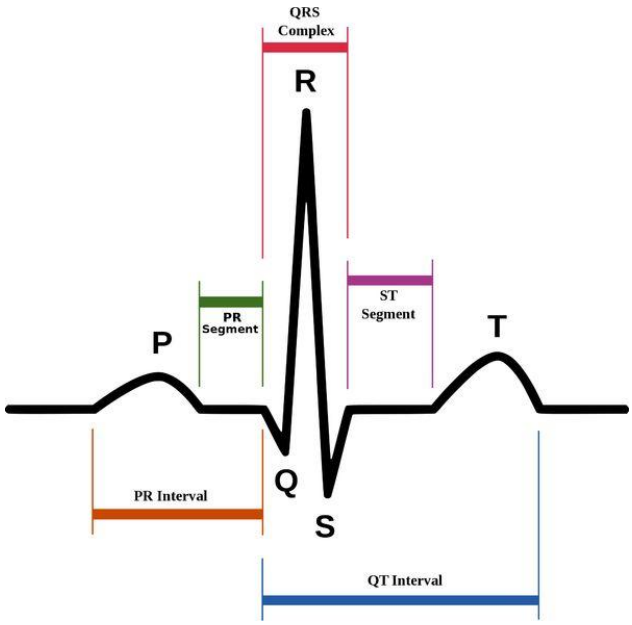


Figure 9 Sinusrhythm

ECG Waves and Intervals (Figure 9) according to Maton & Roshan L. Jean Hopkins, 1993:

- P wave: the sequential activation (depolarization) of the right and left atria
- QRS complex: right and left ventricular depolarization (normally the ventricles are activated simultaneously)
- ST-T wave: ventricular repolarization
- PR interval: time interval from onset of atrial depolarization (P wave) to onset of ventricular depolarization (QRS complex)
- QRS duration: duration of ventricular muscle depolarization.
- QT interval: duration of ventricular depolarization and repolarization.
- RR interval: duration of ventricular cardiac cycle (an indicator of ventricular rate).
- PP interval: duration of atrial cycle (an indicator of atrial rate).

The atrioventricular node (AV node) can also produce electric energy and is known as the secondary pacemaker of the cardiac system. Nonetheless its contraction pace does not exceed 40-50 times and therefore underlies the frequency given by the sinoatrial node. Therefore the main task of the atrioventricular node contains delaying cardiac impulses.

When a wave of excitation spreads out from the sinoatrial node through the atria along specialized conduction channels the atrioventricular node (AV node) is activated. The AV node delays impulses by approximately 0.12s. This delay in the cardiac pulse is extremely important: it ensures that the atria have ejected their blood into the ventricles first before the ventricles contract. This also protects the ventricles from excessively fast rate response to atrial arrhythmias. (Texas Heart Institute)

3. Heart Diseases

This section shortly displays an overview of the differences and the similarities of heart diseases and their origin, i.e. coronary, ischemic, and cardiovascular heart diseases. Further the symptoms of angina pectoris, heart attack, and cardiac arrest are displayed because the first aid application “Defi Now!” might give support when one of these symptoms occurs.

3.1. Coronary Heart diseases

Coronary heart disease describes the narrowing or blockage of the coronary arteries, mainly caused by atherosclerosis, a condition in which an artery wall thickens as a result of the accumulation of fatty deposits (plaque) and cholesterol. These plaques may diminish blood flow to the heart muscle by clogging the artery and as a result may cause abnormal artery tone and function (Figure 10). (Maton & Roshan L. Jean Hopkins, 1993)

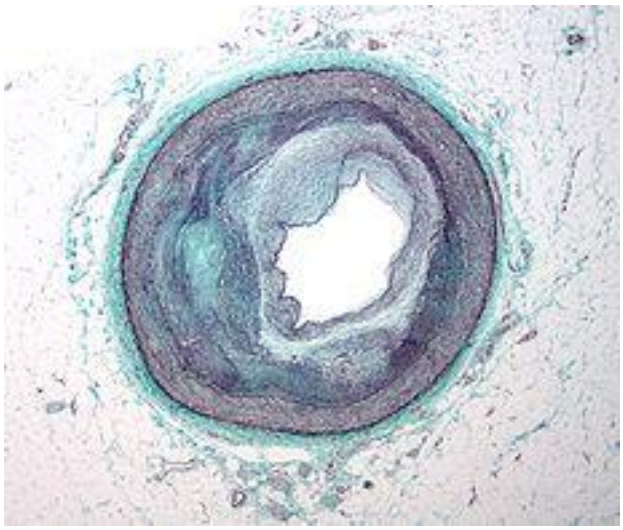


Figure 10 Atherosclerosis

If blood supply of the heart is restricted, less oxygen reaches the heart and vital nutrients such as glucose and oxygen, which it needs to work properly, are absent. This can cause chest pain called angina pectoris and is further explained in section 3.4.

If blood supply to a portion of the heart is obstructed entirely, or if the energy demands of the heart become much greater than its blood supply, a heart attack - denoted by an injury of muscle tissue -may occur. Signs and classification can be viewed in detail in section 3.5.

3.2. Ischemic Heart Disease

Physicians also differ between nonischemic and ischemic heart diseases, where nonischemic simply means not showing signs of ischemia. The latter denotes a restriction in blood supply, causing shortage of nutrients, which are vital for the cellular metabolism. Ischemia occurs due to the fact of underlying problems with blood vessels, with the result of dysfunction or even damage of tissue. Ischemia may also be a cause for angina pectoris or other heart diseases. (Science Daily)

3.3. Cardiovascular Disease

All clinical pictures concerning the heart or blood vessels (arteries, capillaries and veins), such as cardiac disease, vascular disease of the brain and kidney, therefore principally all diseases affecting the cardiovascular system can be summarized as cardiovascular diseases.
The causes for cardiovascular disease are diverse, but nevertheless the most common causes for cardiovascular disease are atherosclerosis or hypertension. Cardiovascular disease remains the biggest cause of deaths worldwide, with a mortality rate of 352.689 in Germany in the year 2010. (The Information System of the Federal Health Monitoring, 2011)

3.4. Angina pectoris

Angina pectoris denotes chest pain due to ischemia of the heart muscle, mostly due to spasms of the coronary arteries. As described in section 3.1., angina is caused by atherosclerosis of the arteries enriching the heart with blood. The term angina pectoris derives from the Latin “angina” ("infection of the throat") from the Greek *ἀγχόνη ankhonē* ("strangling"), and the Latin *pectus* ("chest"), and can therefore be translated as "a strangling feeling in the chest". (M.D., 2000)

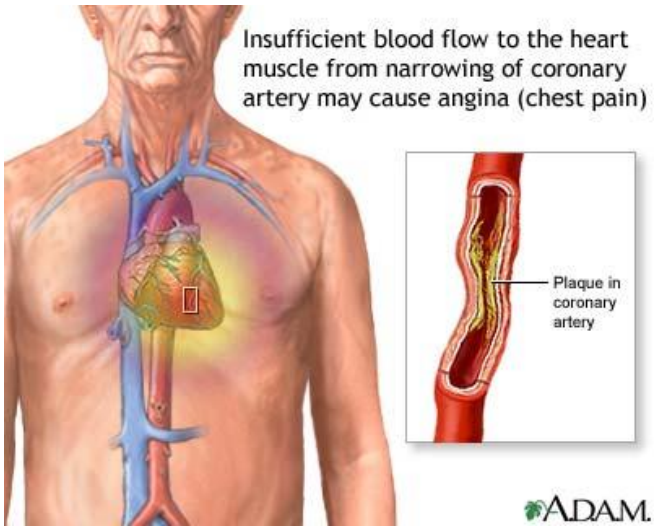


Figure 11 Angina

Medics differ between stable and unstable angina. Stable angina is noticed by patients by experiencing chest discomfort and associated symptoms evoked by some physical activity such as running or walking. These symptoms typically subside after several minutes of rest and reoccur when activity resumes. However, patients generally do not show signs of symptoms when at rest.

Unstable angina is a form of angina pectoris that changes or worsens. According to Hombach (2001) it is characterized by at least one of these features:

- It occurs at rest (or with minimal physical effort), usually lasting more than 10 minutes
- It is severe and of new onset (i.e. within the prior 4-6 weeks) or
- It occurs with a crescendo pattern (i.e. distinctly more severe, prolonged, or more frequent than before)

The symptoms of unstable angina are often confused with those of a myocardial infarction (heart attack – see next section) and may be a premonition of a heart attack. Therefore they are generally treated as a presumed heart attack and require urgent medical attention. (Hombach, 2001)

3.5. Heart Attack

Every year, more than 250.000 Germans and about 1.000.000 Americans suffer from a heart attack – a sudden interruption in the heart's blood supply. This happens when there is a blockage in the coronary arteries, the vessels that carry blood to the heart muscle. When blood flow is blocked, heart muscle can be damaged very quickly and die. Prompt emergency treatments, such as Cardiopulmonary or Cardiocerebral Resuscitation (see section 4) and/or administering electric shocks to the heart by an Automated External Defibrillator (see section 5), in order to restore a normal rhythm, have reduced the number of deaths from heart attacks in recent years. (Mallinson, 2010)

Typical symptoms of a heart attack include chest pain typically with radiation to the left arm or left side of the neck, shortness of breath, nausea etc. Women experience fewer typical symptoms than men and are therefore often mistreated. Most common symptoms for women are shortness of breath, fatigue and a feeling of indigestion.
A heart attack is the most severe cause of death in western countries for men and women and must always be medically treated immediately so as to save the heart from as much damage as possible. (Mallinson, 2010)

3.6. Cardiac Arrest

Cardiopulmonary arrest, or short cardiac arrest, denotes the cessation of normal blood circulation due to the hearts inability to contract effectively. While suffering from a heart attack, blood flow is impaired, but it is completely cut off during a cardiac arrest. This prevents blood to deliver oxygen to the body which eventually leads to loss of consciousness and abnormal or absent breathing. If cardiac arrest is untreated for more than 5 minutes, brain injury is likely to occur. (Mallinson, 2010) (Safar, December 1986)
The most common cause for cardiac arrest is a disturbance in the heart rhythm called ventricular fibrillation, meaning an abnormal or irregular heart rhythm in which there are rapid uncoordinated fluttering contractions of the lower chambers (ventricles) of the heart. Ventricular fibrillation is commonly associated with heart attacks and scarring of the heart muscle from previous heart attacks. (Maton & Roshan L. Jean Hopkins, 1993)
Cardiac arrest, if treated early, may be reversible in certain situations. For best chance of survival and minimized neurological damage as possible immediate treatment is essential. The treatment for cardiac arrest comprises cardiopulmonary resuscitation (CPR) to provide circulatory support, followed by defibrillation, which will be described in the next section.

4. Cardiopulmonary Resuscitation

Cardiopulmonary resuscitation (CPR) is a procedure performed to restore a person's spontaneous blood circulation and preserve intact brain function in case a person is suffering from cardiac arrest or a person with no vital signs. CPR is a manual treatment, which is indicated until further treatment, such as defibrillation (see section 5) is available. Time is a very important factor when an unconscious person is not breathing. Permanent brain damage begins after only 4 minutes without oxygen, and death can occur as soon as 4 - 6 minutes later. (Plus, 2012)

CPR involves chest compressions which shall be performed at least 5 cm deep and at a rate of at least 100 per minute (Figure 12 and Figure 13)[1]. In addition the rescuer may provide breaths by either exhaling into the unconscious person's mouth or nose in order to push air into the subject's lungs. If the rescuer decides to perform artificial respiration they are supposed to give 30 chest compressions fast and hard before breathing due to the latest CPR standards. Therefore the head of the subject is tilted backward and the chin is lifted as can be seen in Figure 14. To prevent the exhaled air to escape through the nose, the rescuer has to pinch it. The mouth of the unconscious person is supposed to be covered by the rescuers mouth and the rescuer has to exhale until the rising of the chest is noticed. 2 breaths shall be given due to the latest standard. Each breath should take 1 second. After breathing twice the procedure of 30 chest compressions and 2 breaths are repeated until the person shows signs of return of spontaneous circulation (ROSC) or help arrives. If an AED is available its use is recommended as soon as possible (see section 5).

Figure 12 Region for Chest Compressions

[1] Learn CPR is a free public service supported by the University of Washington School of Medicine. The American Heart Association issued updated CPR guidelines in October, 2010. http://depts.washington.edu/learncpr/index.html

Figure 13 Chest Compressions

Figure 14 Artificial Respiration

Compression-only (hands-only or cardiocerebral resuscitation) CPR is a technique that involves chest compressions without mouth-to-mouth (or mouth-to-nose) respiration. It is recommended as the method of choice for the untrained rescuer because it is easier to perform and instructions are easier to give over the phone while being connected to the emergency call. In adults with out-of-hospital cardiac arrest, compression-only CPR by the lay public has a higher success rate than standard CPR with the exceptions of drownings, arrest in children and drug overdose. The method of delivering chest compressions remains the same, as does the rate (at least 100 per minute). It is hoped that the use of compression-only delivery will increase the chances of the lay public delivering CPR. (Nagao, 2007) The following Figure 15 shall provide an overview regarding the types of cardiac arrest and the accompanied return of spontaneous circulation and concurring survival rate.

Type of Arrest	ROSC	Survival Rate
Witnessed In-Hospital Cadiac Arrest	48%	22%[2]
Unwitnessed In-Hospital Cardiac Arrest	21%	1%
Bystander Cardiocerebral Resuscitation	40%	6%
Bystander Cardiopulmonary Resuscitation	40%	4%[3]
No-Bystander CPR (Ambulance CPR)	15%	2%
Defibrillation within 3-5 minutes	74%	30%[4]

Figure 15 Overview of Survival Rate Dependent on Type of Cardiac Arrest

[2] (Brindley et al., 2002)
[3] http://web.archive.org/web/20070612203024/http:/www.resus.org.uk/pages/compCPRs.htm (Nolan, 2007)
[4] http://www.heart.org/HEARTORG/

5. AED – Automated External Defibrillator

Ventricular fibrillation often can be treated successfully by applying an electric shock to the chest with a procedure called defibrillation. The survival rate in coronary care units is relatively high, since defibrillation is performed almost immediately when patients suffer from cardiac arrest.
But if cardiac arrest occurs outside the hospital, the situation is opposite. The chances of reviving a person experiencing cardiac arrest are very poor, unless defibrillation can be performed within the first minutes after the onset of ventricular fibrillation. Every minute that passes narrows the chance of resuscitation by almost 10 percent. After 10 minutes the chance of survival is reduced to nearly zero percent. (emedicine health, 2012)
An automated external defibrillator (AED) is a portable device that checks the heart rhythm (Figure 16). If cardiac arrhythmia is measured, it can send an electric shock to the heart in order to restore a normal rhythm.

Figure 16 Automated External Defibrillator

An AED unit consists of two electronic pads, which are placed on the affected person's chest (Figure 17). The fact that the electronic pads are placed on the chest delivers the term "external defibrillator". Internal defibrillators on the other hand have electrodes, which are surgically implanted inside the patient's chest.

The term “automated” refers to the unit’s ability to autonomously analyze the patient’s condition via an integrated cardiac ultrasound scan. The vast majority of these systems (e.g. AEDs developed by BEXAMED medical engineering) have spoken prompts to instruct the user, for example in connecting the electrodes to the patient. To ensure accessibility, AED units are gradually equipped with visual guidance as well, in case a bystander might be hearing-impaired (e.g. AED Units developed by ZOLL Medical Corporation).

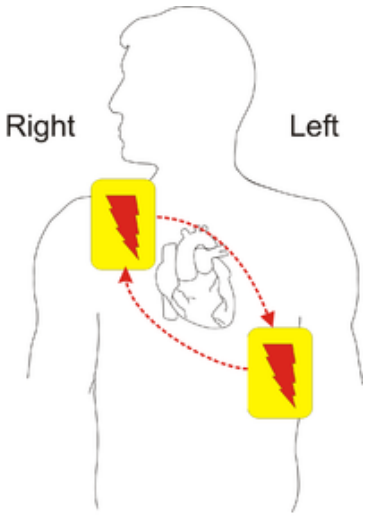


Figure 17 Position of Electronic Pads

Once the electronic pads are attached as seen in Figure 17, the unit begins examining the electrical output from the heart and determines whether the patient is in a shockable rhythm (either ventricular fibrillation or ventricular tachycardia). If the device recognizes the need to defibrillate, the battery enclosed in the AED will be used to charge its internal capacitor in preparation to deliver the shock. When charged, the system instructs the user to remove his hands from the patient’s body and then press a button to deliver the shock (Figure 18). This mechanism of human intervention avoids injury of other persons and ensures users that they do not receive a shock accidentally. After the shock is delivered the device will analyze the patient again and either instruct the bystander to resume with CPR or administer another shock. Automated external defibrillators require minimal training to use unlike regular defibrillators, which are supposed to be handles by medical personnel only.

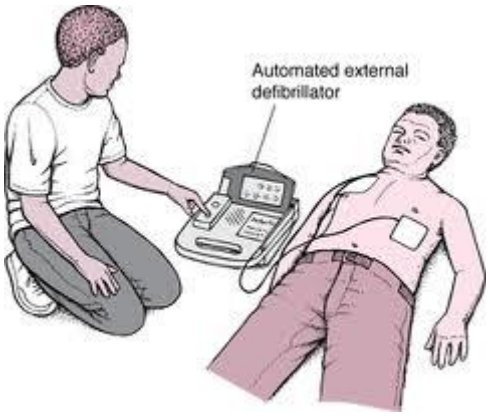


Figure 18 Initiating a Shock with an Automated External Defibrillator (AED)

The establishment of automated external defibrillators (AEDs) in public places has proved helpful, as studies show. A study by Myron L. Weisfeldt et. al. (2007) proved that the survival rate of people suffering from cardiac arrest in public places have nearly doubled, when defibrillation is initiated within few minutes by bystanders compared to merely applying CPR.

A study conducted by a volunteer fire department in Weinheim (Germany) proves that the utilization of an AED is very simple (Freiwillige Feuerwehr Weinheim, 2012). In line of a first aid course, held especially for children and youths, they were asked to acquaint oneself with the use of an AED. Even before the instructor could begin to explain the device, the children had already begun to open it and followed the instructions given by the device independently. They managed to use the AED properly. Afterwards they were tutored by an instructor, who displayed the correct utilization of an AED.

Before presenting and evaluating a selection of existent first aid smartphone applications from different countries, which might offer guidance in case of an emergency such as cardiac arrest, the next section comprises the evaluation criteria based on software ergonomic principles due to the ISO 9241-110 standards, guidelines referring to the design of user interface presented by Jacob Nielsen Ben Shneiderman (see section6).

6. Usability and Software Ergonomic Principles

Software is measured by the degree of usability depending on the usability context, which arises out of users, their task, their conditions of use and their equipment. Therefore it cannot be evaluated as “bad” or “good” but only as suitable to its purpose.
The adherence of the software ergonomic principles due to the ISO 9241-110 standard - as stated below - ensures goal achievement effectively, efficient and adequate, and hence supplies usability.

Efficacy signifies whether the user is able to perform given tasks with specific software and receives the desired results properly. For example a calculation program must calculate a given term correctly.
Efficiency of software is denoted by the effort a user has to expend to reach their goals. Useful software is supposed to promote work simplification which leads to a decrease of control effort and/or mental work.
Adequacy is measured by the degree of contentment of the user in respect to the software. Hereby matters most their liking of it and their subjective estimation of efficiency when performing tasks. (Redtenbacher)

Usability of software is mainly influenced by the design of tasks (60%), compared to the design of a (graphical) user interface ((G)UI). Software with a less attractive GUI might prove to be more efficient and therefore more ergonomic than software with an aesthetic designed one. (Redtenbacher) To ensure usability of software, seven software ergonomic principles need to be considered when developing an application, based on the international ISO 9241-110 standard. These are known as suitability for learning, controllability, error tolerance, self-descriptiveness, conformity with user expectations, suitability for the task, and suitability for individualization, and shall be characterized shortly. These principles can be considered as general expectations for a user-friendly design of software or accessible interfaces. (Mekelburg, 2010)

- Suitability for Learning

A dialogue system supports learnability if it assists the user during a learning process. If this feature is provided by software, the user is encouraged to explore the software functions via “learning by doing” without having to fear penalization for errors such as data loss at any point.

- Controllability

A dialogue is controllable if the user is able to begin the execution of the dialogue and manipulate its course regarding pace and orientation until the desired goal is achieved.

- Error Tolerance

A dialogue is error tolerant if the intended goal can be maintained with none or minimal adjustment effort in case of recognizable incorrect entries on the user's behalf.

- Self-Descriptiveness

By instructing the user regarding further performances upon user request or automatically, a dialogue system ensures self-descriptiveness. In this sense the user perceives what they must do next and their actions are less error-prone.

- Conformity with User Expectations

A dialogue is compliant with user expectations if it is designed consistently and therefore corresponds to the users expectations based on their knowledge or established standards. Operating software compliant with user expectations is ensued by a coherent manner.

- Suitability for the Task

A dialogue is suitable for the task if it supports the user in performing their tasks without an unnecessary impediment by the properties of the dialogue system. Therefore software suitable for the task only delivers information to the user which they need to achieve their goal. Irrelevant information or dialogue actions that are not needed in context of the user's task performance are not displayed.

- Suitability for Individualization

A dialogue is suitable for individualization if it can be adjusted to the personal abilities and requirements of the user. For example customizable software contains the possibility of adjusting the font size for visual impaired users.

Jakob Nielsen and Ben Shneiderman have each released a framework of system acceptability independently of one another. They shall be mentioned but are not discussed further in line of this diploma thesis. Ben Shneiderman has defined *"Eight Golden Rules of Interface Design"* (Shneiderman, 1998) as:

- *Strive for Consistency*
- *Enable frequent users to use shortcuts*
- *Offer informative feedback*
- *Design dialogue to yield closure*
- *Offer simple error handling*
- *Permit easy reversal of action*
- *Support internal locus of control*
- *Reduce short-term memory use*

Jakob Nielsen has released ten heuristics referring to user interface design (Molich, 1990):

- *Visibility of system status*
- *Match between system and the real world*
- *User control and freedom*
- *Consistency and standards*
- *Error prevention*
- *Recognition rather than recall*
- *Flexibility and efficiency of use*
- *Aesthetic and minimalist design*
- *Help users recognize, diagnose, and recover from errors*
- *Help and documentation*

Some of these rules released by Shneiderman and the heuristics defined by Nielsen coincide and may be summarized, where usability is part of "usefulness" and is composed of:

- Learnability: How easy is it for users to accomplish basic tasks the first time they encounter the design?
- Efficiency: Once users have learned the design, how quickly can they perform tasks?
- Memorability: When users return to the design after a period of not using it, how easily can they reestablish proficiency?
- Errors: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
- Satisfaction: How pleasant is it to use the design?

The main focus during the evaluation of the first aid smartphone applications in the following section lies more on their general appearance as well as the distinction of their given features. The evaluation based on the features regarding usability declared by Shneiderman and Nielsen shall be presented mainly, when discussing the usability of the application "Defi Now!" more specific in section 10 (C. Plaisant, 2012) (Nielsen J.). Moreover "Defi Now!" will be evaluated in reference to the dialogue principles due to the ISO 9241-110 standard.

7. First Aid Applications – State of the Art

With the number of smartphone-owners the amount of downloadable applications increases proportionally (Figure 19). (Das Statistik-Portal) When searching for first aid applications via “Google play”or “ITunes”, more than 1000 applications are delivered. Some of them are free, but others require a payment of 1 Euro up to over 40 Euro. Nevertheless not all of the search results actually hold first aid applications. Some of them are only entertainment applications camouflaged with the keywords “first aid”, such as a gamersguide for “World of Warcraft” (Figure 20).

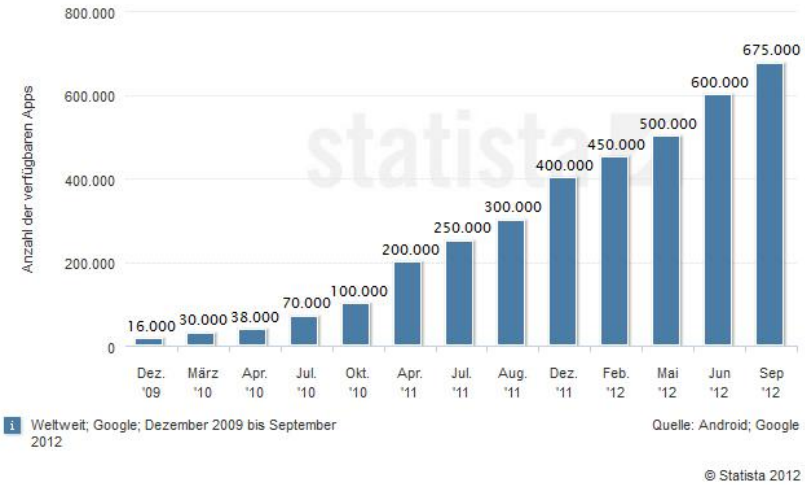


Figure 19 Number of Available Applications

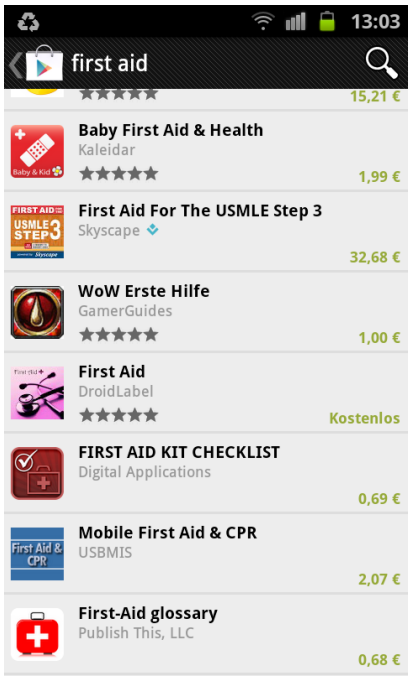


Figure 20 Search Result for Keywords "First Aid"

Despite of these misleading search results, actual first aid applications are displayed as well. Some of them will be discussed during the next section, with focus on their content (e.g. display of first aid measures, distance to the next accessible AED) and general appearance. Hereby only applications for iPhones or Android-based smartphones are discussed because these two operating systems dominate the market worldwide. (Das Statistik-Portal) To gain a good overview, applications from Switzerland, the United States, Austria, France, and Germany are compared and reviewed. These six selected applications provide information regarding the use and distribution of AEDs and were the first to be displayed when searching via “Google play” or “ITunes”. The order of evaluation was chosen randomly and does not imply advantages or disadvantags.

7.1. Lifesaver- Switzerland

This German-only app by Herzsicher AG mainly provides a database in which defibrillators located in Switzerland are stored. If somebody experiences a heart attack or cardiac arrest, the bystanding iPhone-User is able to open the app after calling the ambulance. Based on GPS-Data the user is shown the nearest position of a defibrillator immediately on a city map (Figure 21). The user then has the possibility to either call the number of the building in which the AED is located (for example an office-building) (Figure 22) and order the AED to be brought to the accident scene, or to make use of the internal navigation system of the iPhone to find their way to the AED’s location and fetch it themselves.

The lower tab bar from left to right: Map, Distance, Locations, Help

Figure 21 Locations of the Nearest AEDs

Route to an AED

Show in Map

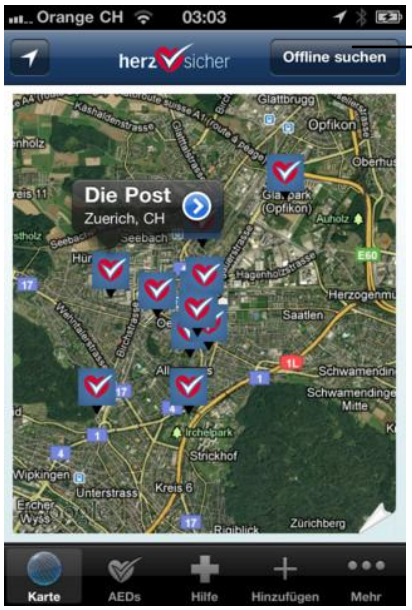
Figure 22 Information Regarding a Specific AED

Delivering GPS-Positions is not always allowed for data protection reasons. For example, in Germany the coordinates may not be transmitted automatically to an emergency call center. However in Switzerland this does not entail any problems and the app “Lifesaver” benefits from this possibility. Once the bystander alerts rescuers, the iPhone automatically sends them an e-mail with the exact location. This seems to be especially helpful if an emergency occurs in a foreign location, and the person providing help is not familiar with the surrounding area.

The App is divided into a map which comprises the AED locations depicted by the applications icon. The lower button “AEDs” leads to a table view of the AED locations, with information such as exact address and distance (Figure 23 and Figure 24).

Figure 23 Table View of "Herzsicher"

A helpful feature is the ability to search offline (Figure 24). Some areas are not equipped with fully developed cell coverage and trying to load a map or table view with site information is impossible or takes a long time, which cannot be wasted if an emergency occurs. Searching offline might improve helping people during an emergency even if the mobile phone network is not available.
“Lifesaver” also contains a possibility to add a new AED location. This feature is appointed vastly in several applications, since it proved to be a sure opportunity to register a great number of AEDs.



Offline search

Figure 24 Offline Search

7.2. Pulse Point – United States of America

The app “Pulse Point”, which is only available in the United States, was introduced January 25th 2011 by the San Ramon Valley Fire Protection District. It arose as a tool designed to support public safety agencies working to improve cardiac arrest survival rates through improved bystander performance and active citizenship. (PulsePoint)

The basic idea is for citizens to dial the emergency number 911. Then a secondary alert will be sent to all the mobile devices of people nearby who have registered as willing and able to provide emergency help. Figure 25 shows such a secondary message providing information regarding the type of help needed and the exact address at which the emergency occurred.

Figure 25 CPR Notification

By default all notifications are off. The user can choose the notifications they like to receive. For example “CPR/AED”-alerts direct trained bystanders to nearby cardiac emergencies. Subscribers to alert notifications will receive a special notification tone indicating the need of CPR nearby. This happens only if an emergency is occurring in a public place and dependent on radius to emergency site. In rural districts the notification radius is larger than in urban districts due to longer local government response times. Higher population densities usually warrant a smaller radius. However, the distance is configurable on an agent-to-agent basis (Figure 26). If desired, the user gets an overview of all fire department emergencies occurring at that precise moment when tapping the lower tab “Incidents”. They may also view the log, which contains all incidents of the past 24 hours (Figure 27).

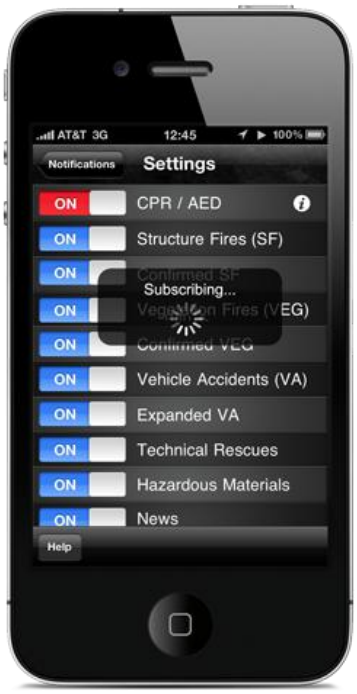


Figure 26 Settings

Figure 27 Incidents

As a second feature, the trained bystander is directed to the emergency site via map and routing. An interactive map displays the incident's location by a red pin. Tapping the button "Show AEDs" reveals all automated external defibrillators nearby the incident's location (Figure 28 left panel). By pressing the button "Hide AEDs" the pins indicating an AED are hidden (Figure 28 right panel). A CPR button located in the map or the table view of incidents serves as a key resuscitation reminder. The app also disposes of a radio tab, which enables a streaming radio feed from the dispatch center of the fire department. The details from all live incidents will scroll in a lower window (Figure 29).

Figure 28 Map with Integrated Option of Showing or Hiding AEDs

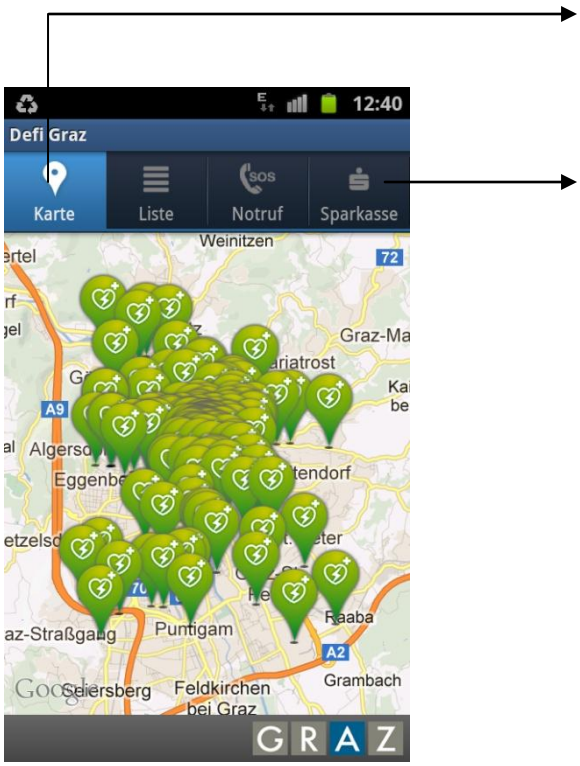
Figure 29 Radio Function

Next to the "Radio" tab, lies the "Photos" tab, which provides a photo gallery from significant incidents from firedepartment.org. The user may scroll through the gallery and select a photo, which they want to view. They then are able to zoom in or out of the photo or pan it (Figure 30).

Figure 30 Photo Gallery

7.3. Defi Graz – Austria

This free downloadable app in German was developed by the Madison agency exclusively for die Austrian City Graz, which shows a high density of defibrillators (Figure 31). “Defi Graz” is structured as a tab-system, as seen before in the app “PulsePoint”. This clear and non-sequential structure allows the user to navigate between the tabs without ever having to use a back-button to attain a previous step. This results in clear time saving, regarding that the app is used in case of an emergency such as cardiac arrest and the user does not have the time to search for diverse functions.



Map

“Sparkasse“ refers to the bank that sponsored the development of “Defi Graz”. Therefore a table view of the nearest bancomats was implemented in the app as a menu tab.

Figure 31 High Density of Defibrillators in Graz, Austria

Because of the neatly arrangement of tabs at the upper part of the screen, the complete rest of the screen is unrestricted usable for displaying main information such as a map with points of interest. Since no other buttons exist on any other part of the screen, the user is not tempted to search for functions elsewhere.

An interesting feature, enhancing the clearness of the app, is the possibility to switch between the map and a table view displaying the locations of the AEDs. This associates the AED’s address with its location in the map and promotes the spatial imagination of users, especially if they are not familiar with the area (Figure 32).

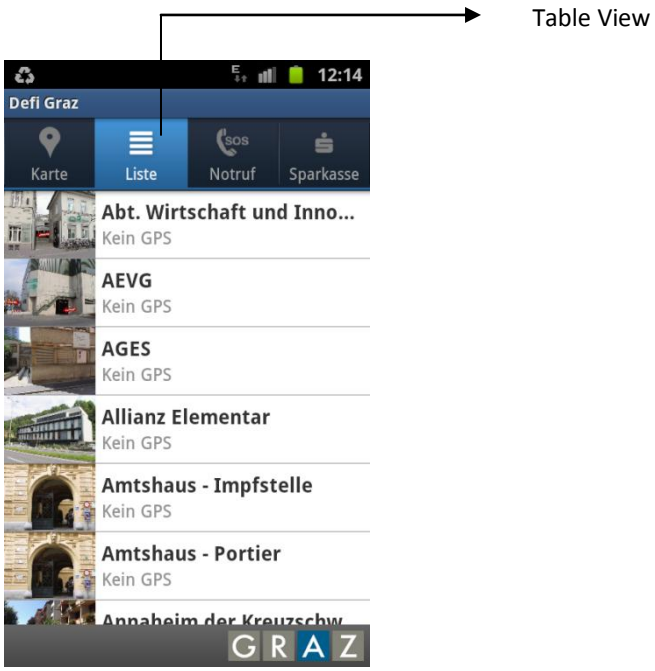


Figure 32 Table View of Existing AED Locations in Graz, Austria

The user is able to choose one of the AEDs in the map by clicking on the desired pin. If a subjacent ordered pin is supposed to be selected, the user has the possibility to zoom into the map until the intentioned pin is reachable. Underlying pins are not selected automatically if the user taps on the same AED location once more. Figure 33 shows that a subjacent pin is selected only when a different x,y-position is activated.
Clicking the balloon belonging to the selected pin delivers more detailed information to the user, such as the exact address, telephone number, and possible opening hours if the AED is located in an official building (Figure 34).

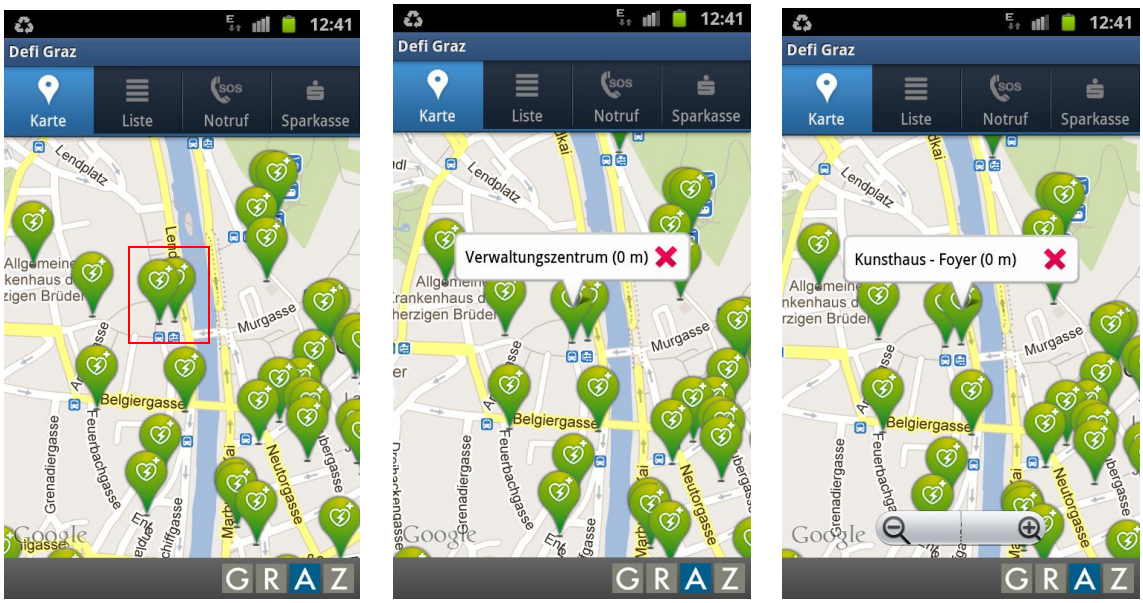


Figure 33 Selecting Subjacent Pins

Figure 34 Additional Information

Performing a click on the balloon for redirection to further information, may be ascribed to the usability of hypertext. Usually to receive additional information, hypertexts embedded in a text lead to detailed information. This feature supports the conformity with user expectations, a software ergonomic principle (see section 6) (Figure 35).

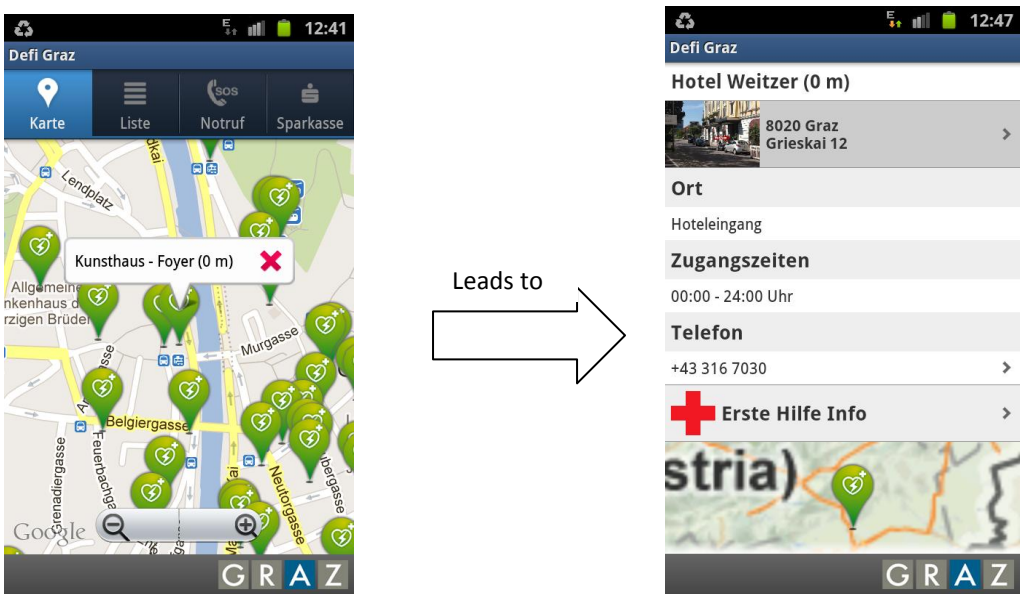


Figure 35 Redirection to Additional Information

If the user wants to close the balloon they simply have to click the red “x”, a feature commonly known from several Windows applications and therefore anticipated by a great number of users (Figure 35).

Assistance regarding first aid is provided when the user opens the more detailed information. The fact that the first aid guidelines possess more graphics and less text may be rated positively because the user would not have enough time to read instructions when assisting during a cardiac emergency (Figure 36).

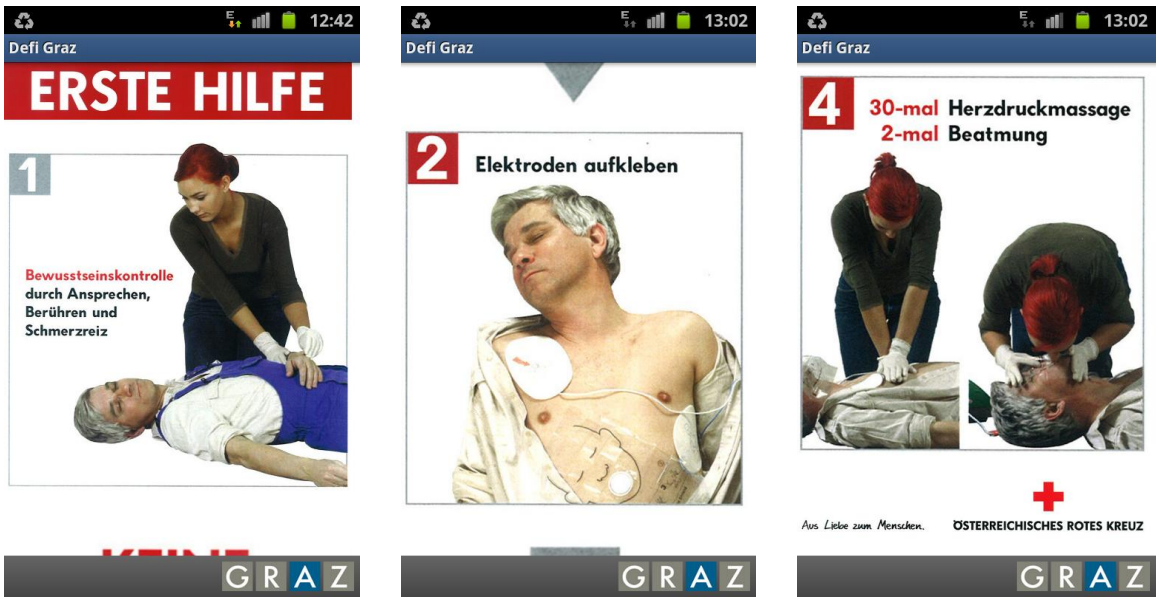


Figure 36 First Aid Measures

Nevertheless the main problem concerning the app “Defi Graz” is the language, since no adjustments regarding a different language are possible. Although the language of the smartphone is set to English, the app “Defi Graz” appears in German language. This yields problems if a foreigner is supposed to use the app, and offering the opportunity to select a different language might be a reasonable enhancement.

7.4. Arrêt Cardiaque 2.0 – France

This French smartphone app by Association RMC/ BMF combines features such as searching for an AED, reporting a new AED, offering help regarding an AED's use, and guidance regarding first aid in case of cardiac arrest (Figure 37). The app "Arrêt Cardiaque 2.0" provides a multilingual interface as well as social network integration. The app may be connected with the user's Facebook and/or Twitter account to share the AED they registered with their network. The integration of social media might serve as a fast way of distributing information about AEDs to a great number of users. Hence it might enforce the awareness of social media users for serious issues such as cardiac diseases, instead of plainly fulfilling the task of entertainment. The more people are aware of such critical issues and involve themselves, the more likely it becomes that they are able to act in an emergency instead of functioning only as bystanders.

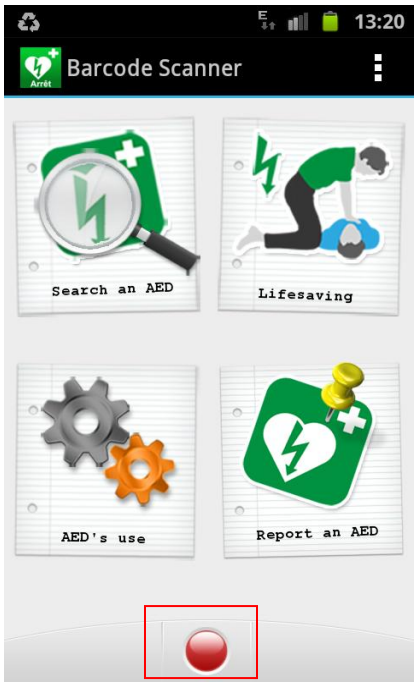


Figure 37 Structure of Arrêt Cardiaque 2.0

As offered in the app “PulsePoint” the user can register as a first responder as well, if they are trained to CPR (only available in France). This allows the subscriber to be reached by the SAMU (French Emergency Service) in case of a cardiac arrest nearby. For example if a cardiac arrest occurs in a shopping center it might be possible that a subscriber of such an emergency notification is in the same building or neighboring area. This way help might be provided more quickly to the person suffering from cardiac arrest compared to the time required for the ambulance to arrive, and the survival rate in case of SCA might be improved.

Pressing the red button at the bottom of the screen activates the emergency mode (Figure 37 as well as Figure 38). By clicking the button “next step” below, the user is sequentially directed through the single steps of first aid in case of sudden cardiac arrest (Figure 38). A metronome, which is also displayed visually for accessibility, sets a rhythm for the first responder to perform CPR (Figure 39). The correct rhythm is essential to assure the CPR’s effectiveness.

Nevertheless, since the red button in neither Figure 37 nor Figure 38 contains any labeling the users must determine its function by themselves. This particular red button resembles the button in Figure 39 merely providing a visual display of the metronome as described previously. It would probably be more self-descriptive if the button in Figure 37 and Figure 38 would be labeled more clearly to avoid any confusion on the user’s behalf concerning the applications functions.

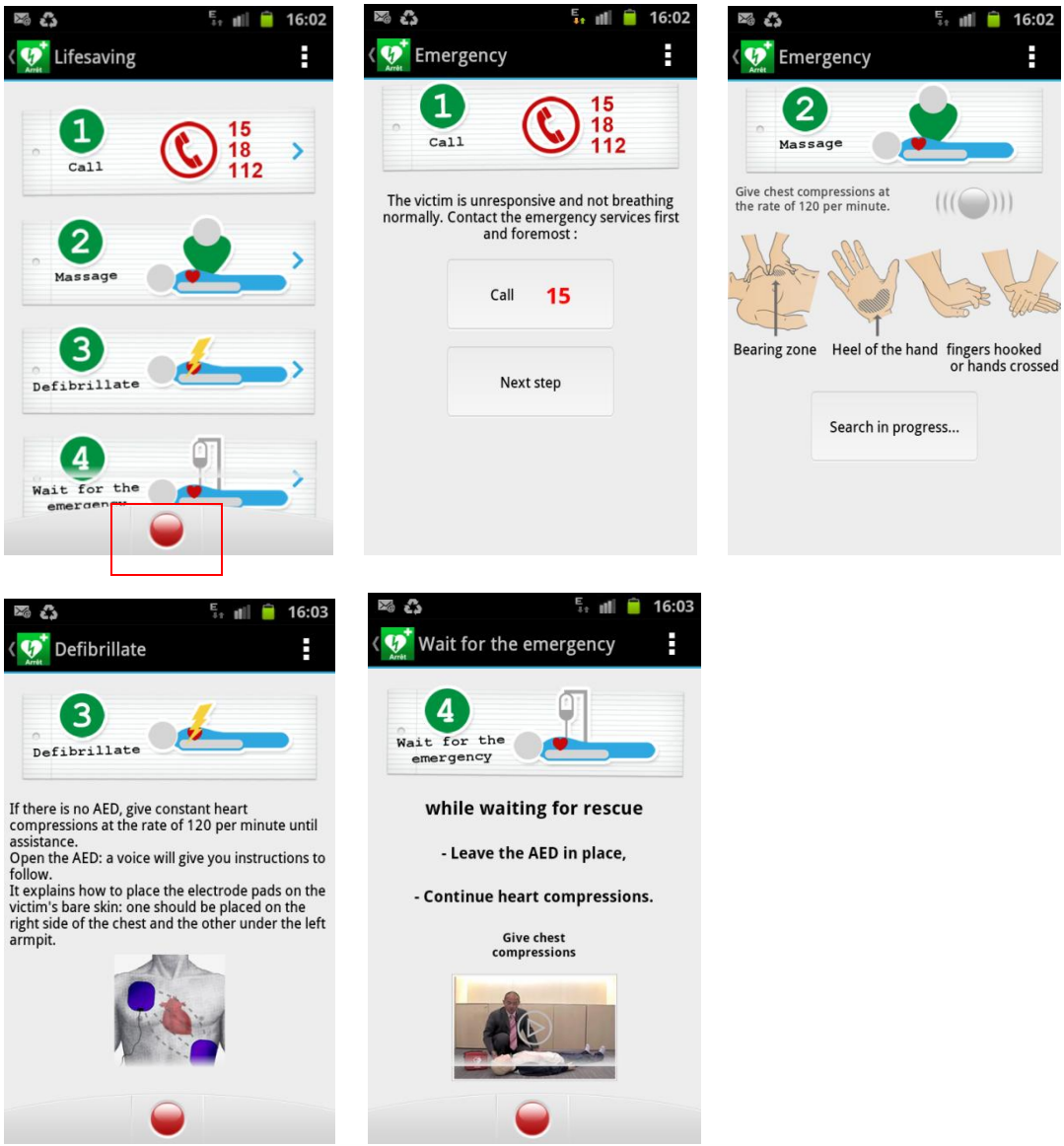


Figure 38 Sequential Direction through the App

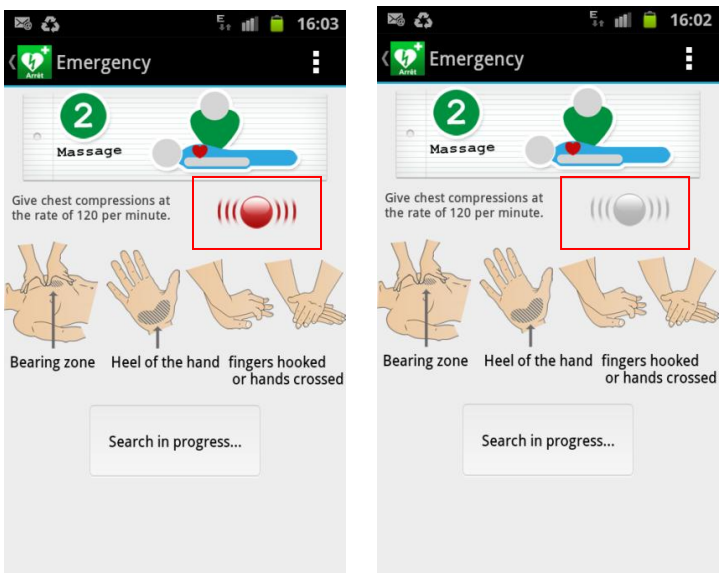


Figure 39 Metronome Presetting the CPR Rhythm

When adding a new AED to the database the user has the possibility to upload a picture of the AED's location. Visual observance is the main way of humans to perceive their surroundings, whereas 60% of information is gathered through the eyes. (Softwareergonomie) The locations coordinates are automatically loaded into the map. To improve and adjust the location the user is able to move the red pin directly on the map (Figure 40).

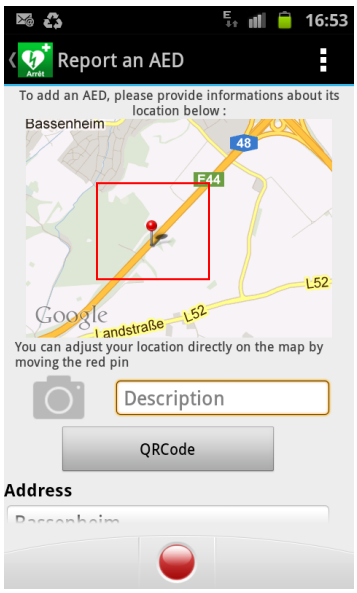


Figure 40 Report an AED and Adjust the Position of the Red Pin

Reporting a problem concerning a registered AED helps improve the AED database. This can be achieved by simply clicking the “Report problem” icon in an AED record (Figure 41). This seems to be a helpful feature. For example in Koblenz, Germany, passersby noticed that an AED was missing and wanted to report this. Because in Germany AEDs are often sponsored by non-profit institutions, it took them a couple of days until they figured out which contact is responsible for that precise AED. This proves to be inconvenient, since people tend to try to settle things quickly, especially when helping out. Investing so much time and effort might discourage people and therefore it would have been better if a specified contact could have been addressed to report the problem. Thus problem reports should be handled centrally.

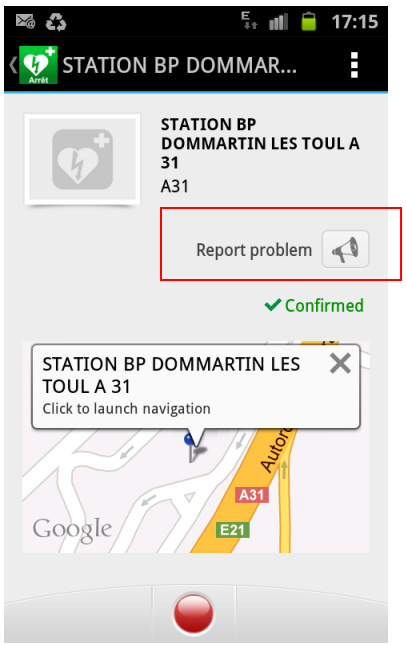


Figure 41 Reporting a Problem Concerning an AED

7.5. AED Locator – Germany

As far as of November 2012 Germany provides two smartphone apps on the basis of first aid regarding sudden cardiac arrest. The "AED Locator" app by INTOStudios displays AEDs locations recorded in a Germany-wide database, which is supposed to be updated weekly. (Herzintakt - Landesarbeitsgemeinschaft Herz und Kreislauf Schleswig-Holstein e.V.)

The GPS position of the user is approximated automatically. Nevertheless the app not always delivers the nearest AED location to the user. According to experiments, the results attained were not user conformal. Although an AED exists within 11 kilometers of the estimated user's position (indicated by the green arrow), the app indicates the nearest AED in over 49 km distance (Figure 42).

Figure 42 The User is Not Shown the Nearest AED

The main problem, though, is the representation of distance as linear distance. When entering the destination address into a route planner (here: Google maps), the time estimated to reach the AED's location amounts to 24 minutes and a 20 kilometers distance (Figure 43 right panel). The "AEDLocator" merely displays a linear distance of 10,402 km (Figure 43 left panel).

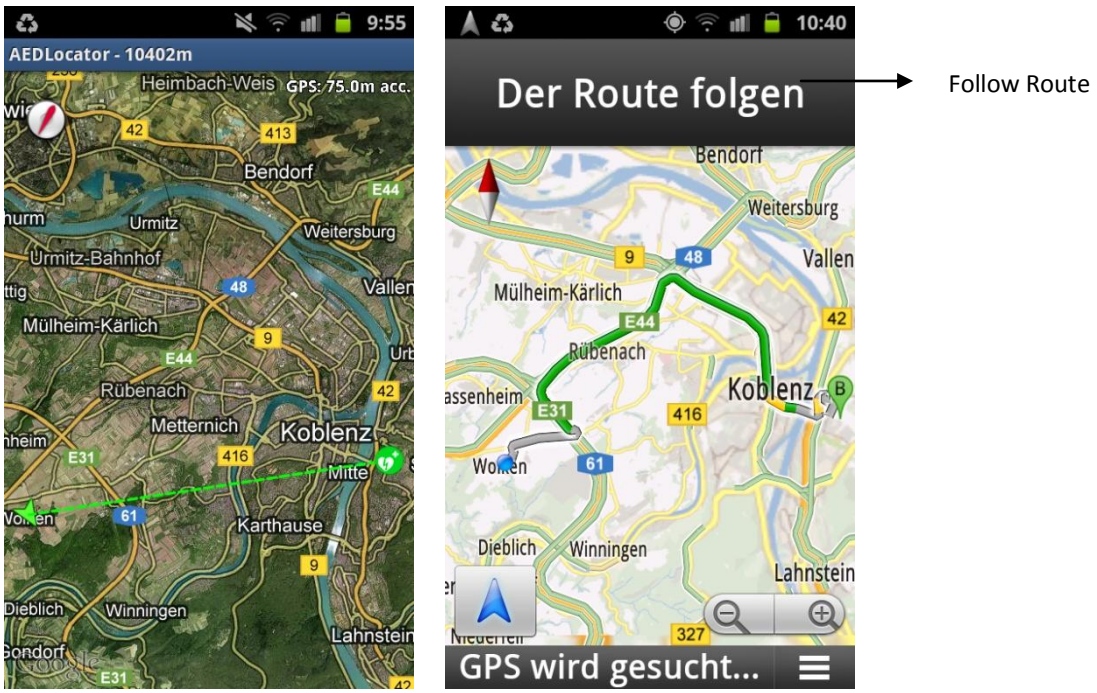


Figure 43 Distance Displayed as Linear Distance in AED Locator and Actual Route in Google Maps

By tapping on an AED icon in the map, the user obtains information about the location's address, but no directions or other information such as opening hours, as seen in the previously introduced apps (Figure 44). Also, when the user searches for AEDs in Koblenz, only one AED is listed. This is incomplete since at least 14 AEDs were installed in areas with public access in line of a big event called National Horticultural Show in 2011 (Bundesgartenschau). Generally, 23 AEDs are installed in the city of Koblenz (Germany) for the time being.

Figure 44 Tapping on a Pin Reveals Only the Address Without Further Information

The “Landesarbeitsgemeinschaft Herz und Kreislauf in Schleswig-Holstein e.V.“ , who runs and updates the German-wide database „aed-kataster.de“ states on their website that they are dependent on voluntary contributions to the database by the population or other institutions. Themselves, they cannot do research on AEDs’ locations in other states in Germany except Schleswig-Holstein or other countries worldwide for financial reasons.

As well as the user of the Swiss app “Liversaver” (see section 7.1), the user of this particular app also has the possibility to search for AED locations offline. The complete database is stored on the user’s smartphone and requires about 350kb. This allows the user to obtain information from the database without permanently having to be online. This might prove helpful in regions with poor cell coverage. (appszoom)

7.6. Defi Now! – Germany

The multilingual iPhone application “Defi Now!“ was developed in line of a diploma thesis by Thomas Lange, a computer scientist of the University of Koblenz-Landau. (Lange, 2011)
The language of the app is automatically adjusted dependent on the user’s phone settings. If the user has for example chosen English as the general language the app appears in English as well. The app is divided into three consecutive steps. The first step comprises the function of making an emergency call, followed by a guideline to performing first aid. Further the user of this application has the possibility to search for AED locations via an interactive map or table view (Figure 45).

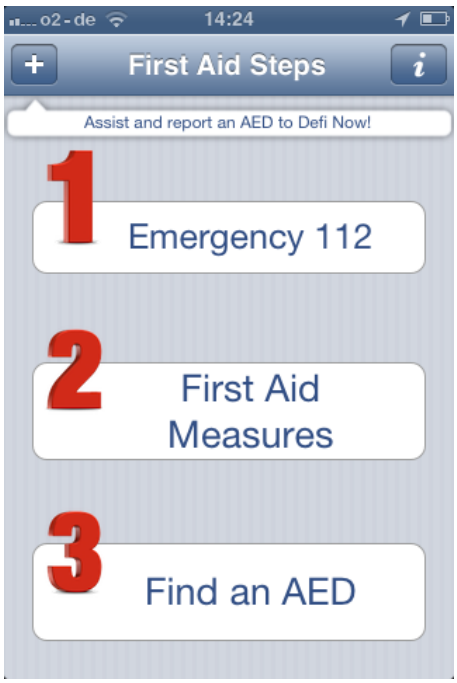


Figure 45 Main Menu of the iPhone Application "Defi Now!"

If the user dials the national emergency number, which is always automatically adapted to the user’s whereabouts, by pressing the button “Emergency Call” they are directed to and questioned by a dialogue system. They are asked whether they actually want to place the emergency call, a valid precaution in case the user does not want to make an emergency call, because they might just test the application out of curiosity with no imminent emergency (Figure 46). Otherwise, if this precaution would not be implemented, the application’s users might unwillingly perform hoax calls to emergency services, which will be penalized with a fine.

Figure 46 Precaution When Pressing the Button "Emergency Call"

The current address is displayed to the user as soon as they enter the dialogue system by pressing the button “Emergency Call” (Figure 46). This might prove helpful if the user is in a foreign region and does not know the location’s precise address. Otherwise they would not be able to direct the ambulance to the emergency site or at least would waste precious time trying to explain their location because GPS data is not automatically send in Germany – as mentioned earlier.

Once the user has made the emergency call they are given the opportunity to make use of the guidelines of administering first aid by pressing the button “First Aid Measures”. A graphic is displayed to them as a diagram divided into a guideline based on the fact that the victim shows vital signs opposed to the victim showing no vital signs (Figure 47).

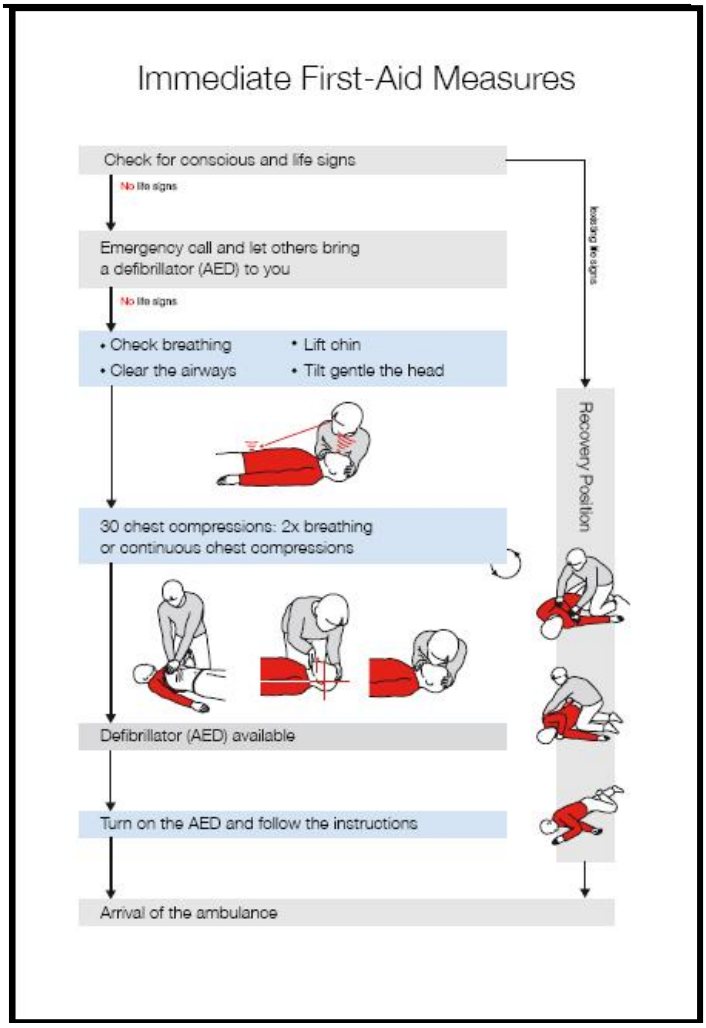


Figure 47 Guideline for Administering First Aid

If the victim shows no vital signs the application's user receives instructions to perform CPR. A metronome presets the resuscitation beat either to 100 times per minute or 30 thorax compressions and 2 mouth-to-mouth respirations or (mouth-to-nose respirations). The user has the possibility to change the settings regarding the resuscitation beat, offering them an extent of individualization (Figure 48).

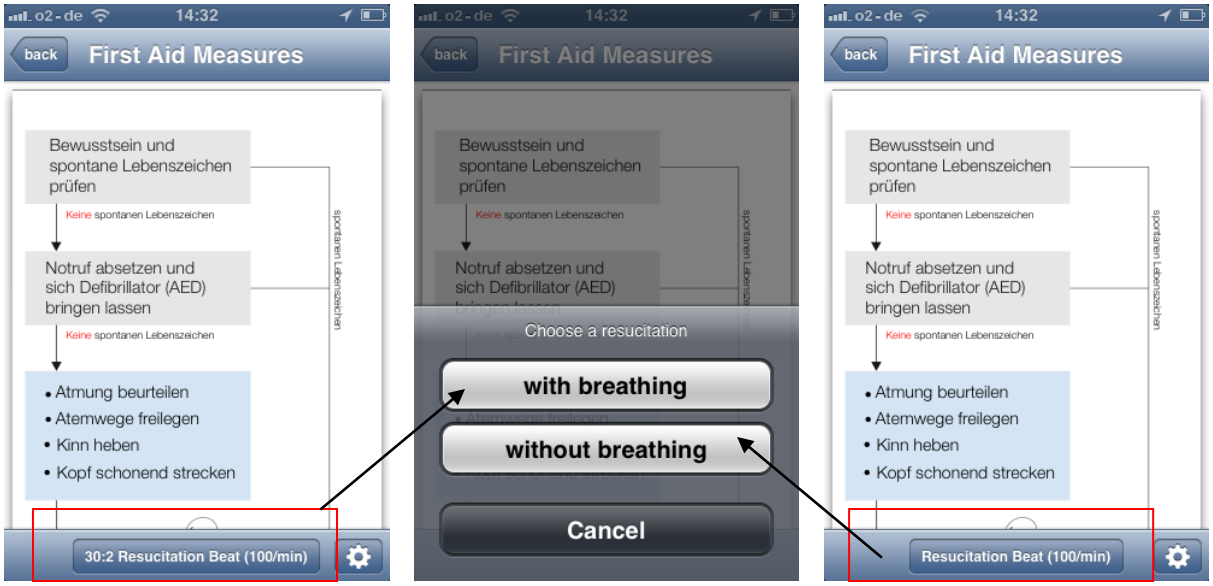


Figure 48 Changing the Resuscitation Beat

Further the user is able to search for AED locations in an interactive map, attaining this feature by pressing the button “Find an AED” on the top-level (Figure 45). On the map, the AEDs are depicted by the commonly known pins (Figure 49). The AED icons are distinguished in four different categories (Figure 49). Green icons depict verified AEDs, confirmed from the “Defi Now!”-team or their regional partners. Grey icons signify still unconfirmed AEDs reported from the general public. A red cross on white background implies places where medical staff is available, such as hospitals. Blue icons refer to AED locations retrieved by the database AED-Kataster. (Herzintakt - Landesarbeitsgemeinschaft Herz und Kreislauf Schleswig-Holstein e.V.)

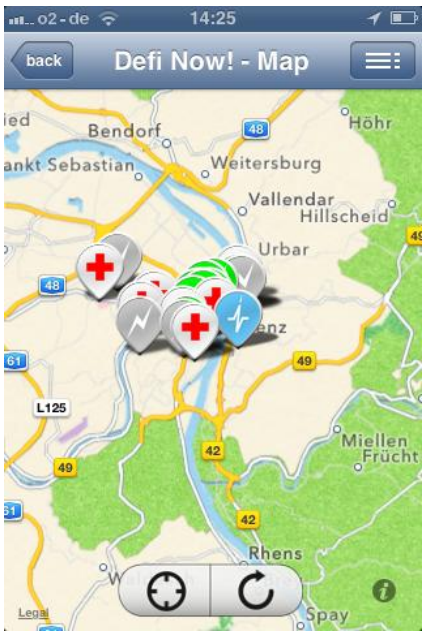


Figure 49 AEDs Depicted by Pins

As a measure of collecting a great number of AED locations, users of this app have the opportunity of registering a new AED to the database. Therefore the user has to sign up and enable the use of an own username and password to add or edit an AED. They then can add the associated data regarding the AED location's address, as well as opening hours of the building given the fact that the defibrillator is not in a place with public access 24/7. For better visual understanding the editor might even upload a photo of the AED's position and describe it in textual form. (Lange, 2011) To test the usability of this application further, a study was conducted with 74 participants, which will be discussed in the following sections.

8. Participants and Usability Study Setup

To test the usability of the given iPhone application „Defi Now!“, a survey was developed and conducted. Although the Android operating system is the most prevailing one with about 50%, the iPhone-version of the app was utilized to perform the tasks because it is more well-engineered than the Android-version of “Defi Now!”. Furthermore Apple iOS is second leading in statistics of the year 2011 and 2012, holding about 20% (Figure 50).

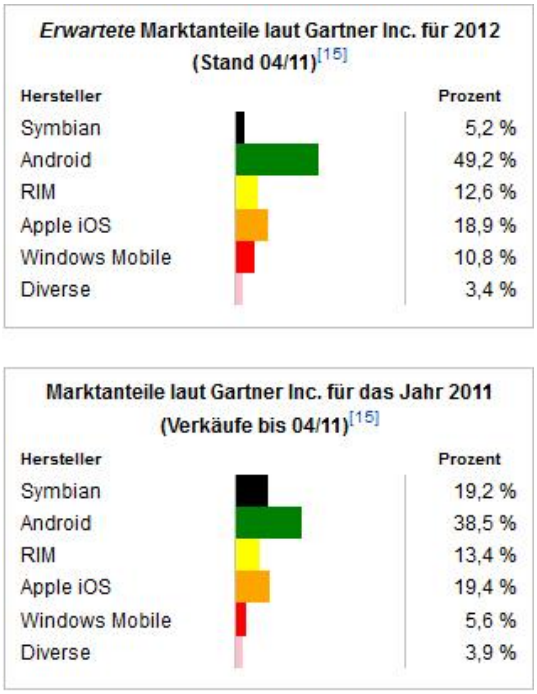


Figure 50 Leading Operating Systems in 2011 and 2012

The app was designed for a potential target group with no limitations concerning age, gender, heritage and occupation. Therefore the usability study comprises of 74 participants, of whom 35 are female and 39 are male. Nine of them have been or still are students of computer science at the University of Koblenz-Landau in Koblenz. Another eight participants are doctors or qualified medical employees. The other 57 participants have different occupations, such as fitness trainer, banker or steel mill worker. Four of these 74 usability study participants related that they had even experienced a heart attack themselves; one of them even suffered from a sudden cardiac arrest and had to be resuscitated.

The usability study was conducted in no specific setting. Passersby, as well as patients in the waiting room of a doctor's office were asked if they were interested to participate. Also customers of a fitness center were addressed during this survey. They were asked whether or not they have some spare time and are willing to participate in a study concerning first aid in regard to sudden cardiac arrest. Most of those asked did not seem very interested, though, and some of them even reacted hostile. Following from their statements, it became clear that the majority did not want to be bothered with such a delicate subject and repressed that they might be dependent on the help of others, in case they experience a sudden cardiac arrest themselves.

The reluctance to help and the consequential bystander effect has become conspicuous during studies conducted by Latané. (Bibb Latané, 1968) One might infer from this reluctance to involve themselves in a survey concerning such an essential issue, a reflection of their disposition to involve themselves actively in an emergency situation and help a person in need.

To those who did want to participate a questionnaire was handed, which is divided into three sections (see appendix). The first section consists of introductory questions regarding the test persons age, sensitivities and medical condition. The issue of their medical condition as well as their sensitivities seemed important since these factors might influence the results regarding errors and learnability. For example a person who is caught in an emergency situation might not react as calm as a person knowing that they are only contributing to a usability survey. On that account a realistic study setup was intended. However, so as not to put any testees participating in this study under psychological pressure, it was decided against a realistic study setup for ethical reasons. (Forschungsrichtlinien Ethik DGPs, 2004) This was also recommended by Jun.-Prof. Dr. Anna Baumert, a psychologist from the University Koblenz-Landau in Landau who gave guidance prior to the usability study setup.

Nevertheless, when witnessing an emergency situation such as cardiac arrest, bystanders and rescuers usually are showing signs of excitement, for example trembling hands. To agitate the test participants, showing a short sequence of a movie proved to be expedient. (Gross, 1995) (Hagemann, 1999) An updated list was published by Hewig et. al. in 2005. (Hewig, 2005)
Despite a low application of this technique, Otto figures that the presentation of film clips is the most effective procedure to induce emotions. Rottenberg & Gross explain this circumstance with the high attention and the intensive experience tied to watching a film clip. (Schleicher, 2009)
Therefore a film clip was selected from the movie "The Shining" (1980), showing a playing child who heads towards a closed hotel room door. The viewer obtains a feeling that something terrifying is lurking behind the closed door. Hagemann et al. and Hewig et al. rated this film clip to induce an emotion of fear as the relevant emotion in the respondent.

The questionnaire was handed to the participants in different settings as stated before. One participant at a time was seated at a desk, with an iPhone 3G S (iOS 6.0.1) in front of them, at which they were asked to perform assigned tasks predefined by the questionnaire. These actions were captured via a camcorder (Plawa DV-4 SD-Camcorder; image resolution 4.0 MP), which was only focused on the iPhone's display to ensure anonymity of the test participants. The video capturing was used to reconstruct the handling of the application "Defi Now!" and to survey the errors made during task-fulfillment.

9. The Questionnaire

During the preceding questions of the questionnaire (attached as an original version as well as a translated version in the appendix) the participants were asked to state their personal condition in respect of discomforts. Discomforts, such as high blood pressure and/or the ingestion of medication to lessen discomforts of any kind, might have an influence on the participants handling of the app during the test situation.
Fatigue or restlessness might also have an influence on the participants' behavior in course of handling the application. Recording this data might allow to determine a different operability if participants are in a good physical condition or are influenced by physical discomforts. (Schleicher, 2009)

The study participants were asked during the preliminary part of the questionnaire to state the emotion provoked when watching the short film sequence of "The Shining", based on an experiment performed by Schleicher (2009). One group of 54 participants was shown the film clip to induce signs of excitement of any kind. The other group of 20 testees functioned as a control group and did not view the film clip before fulfilling tasks via the iPhone. The distribution in the control group regarding age, gender, heritage etc. was equally diverse compared to the group of 54 testees who were shown the film clip. Recording this data might determine a different operability if participants underlie a stressful situation. The group of 54 participants was able to choose one of five predefined emotions (Happiness, Grief, Fear, Disgust, or No Emotion) or could add their own experienced emotion if none of the predefined ones matched.

Besides stating their personal physical condition the participants were asked how they felt. They were able to indicate whether they felt good, relaxed, nervous, anxious, tired, or had a bad temper. These indications also have an influence on a person's behavior, especially in stressful situations and are important to determine when testing the usability of software, which requires precise handling. (Schleicher, 2009) Phrasing these questions as closed questions is supposed to allow the testee to answer quickly and easily. Also, the evaluation of these items is simplified due to the fact that the answers are homogeneous. (Changing Minds.org)

The next part of the questionnaire consists of nine tasks which had to be fulfilled using the smartphone application "Defi Now!". For answering, the study participants were able to judge the given functions by means of a five-stepped rating-scale, ranging from 1=not applicable at all to 5= completely applicable. The rating-scale was developed in reference to Rohrmann (1978), who delivered several proposals for classifying rating-scales, for a good introduction see e.g. Bühner (2011).

The advantage of this evaluation-technique lies in the receipt of differentiated information concerning a specific item. To allow the testees to phrase their own thoughts, every task supplied the possibility to add a comment verbalized as an open question. The advantage of open questions is based on the invitation to the respondent to reflect, which might yield good ideas from which the software engineer might benefit. (Changing Minds.org)

The last part of the questionnaire consists of questions regarding whether the testee owns a smartphone themselves and if in their opinion language statements are helpful, especially regarding this first aid app. Moreover they were asked when they attended their last first aid course and if such an app might be a useful addition in an emergency such as cardiac arrest. For the results obtained in line of this study see section 10.

10. Evaluation

In line of this usability study there will be no differentiation between gender, age, heritage and/ or occupation, since there were no conspicuities to record. The returned results in percent relate to all 74 study participants.
During the preliminary section of the questionnaire, the study participants were asked to indicate their age. Five testees stated to be under 18 years, 18 were between 19-29 years, 19 participants belonged to the age group of 30-45 year-olds. The largest group was formed by the 46-60 year-olds and 11 participants were of an age higher than 60 (Figure 51).

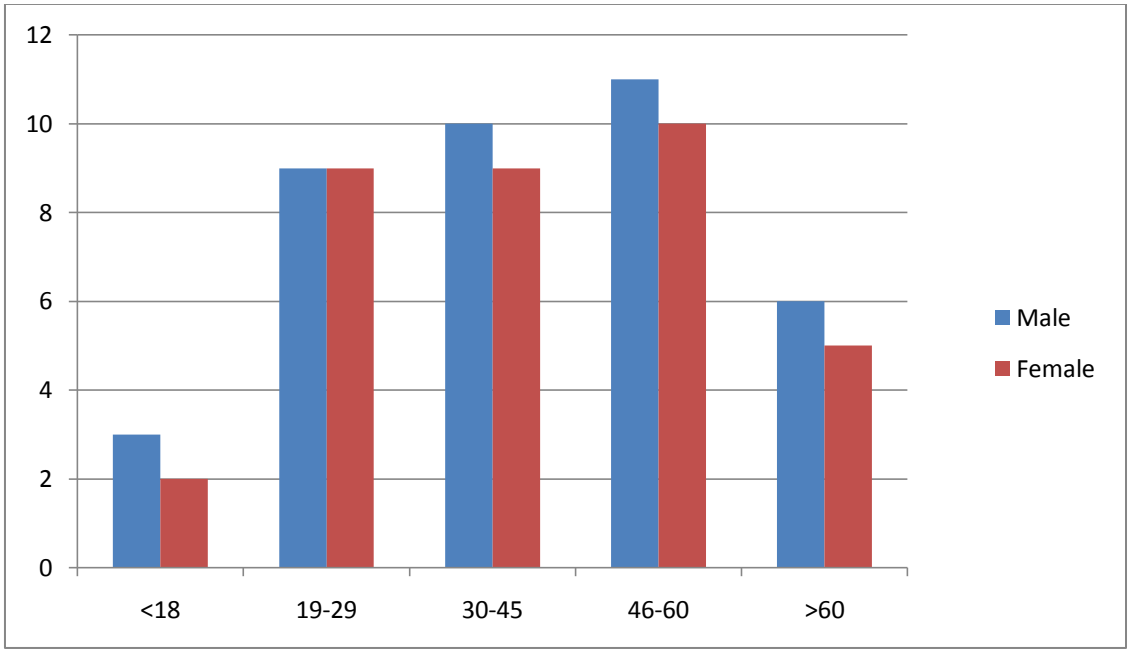


Figure 51 Distribution of Usability Study Participants

Nevertheless there were no divergences to record in handling the smartphone application "Defi Now!" between the two evaluated participant groups. The error rate by both groups, though, might lead to the assumption that the testees all experienced a tense emotion when finding themselves in such a test situation.

Compared to the same experiment regarding the inducement of emotion performed by Schleicher in 2009 (Schleicher, 2009), the results corresponded. During the experiment by Schleicher, the participants were asked to describe the felt emotion freely and 54.65% of the participants named the emotion intended to be induced by the film clip precisely.
31.59% did not name the relevant emotion directly but described it in other words, for example “dread” instead of “fear”. Only 13.76% were not able to describe the intended relevant emotion. (Schleicher, 2009)
During this usability study, the testees were given five alternatives to answer the question, which emotion they experienced when viewing the film clip (see section 9). 16.67% stated they did not feel any emotion while watching the short sequence. 12.96% had a feeling of disgust. The relevant emotion of fear, which was supposed to be induced by the film clip, was only checked by 16.67%. Nevertheless 14.81% stated they felt anxious and a vast number of participants experienced tension (38.89%). However, if the emotions of tension and anxiety were to be treated as synonyms to the relevant emotion (fear) because of their compatibility, the intended emotion was evoked by 70.37% of the participants (Figure 52).

As illustrated in section 9, the participants were questioned about their current sentiment, with the above mentioned alternatives. 59.46% stated they felt good, 13.51% were nervous. Five participants (6.76%) declared they were tired and another two felt anxious (2.70%). None of the testees had a bad temper and 14.86% stated they were relaxed (Figure 53).

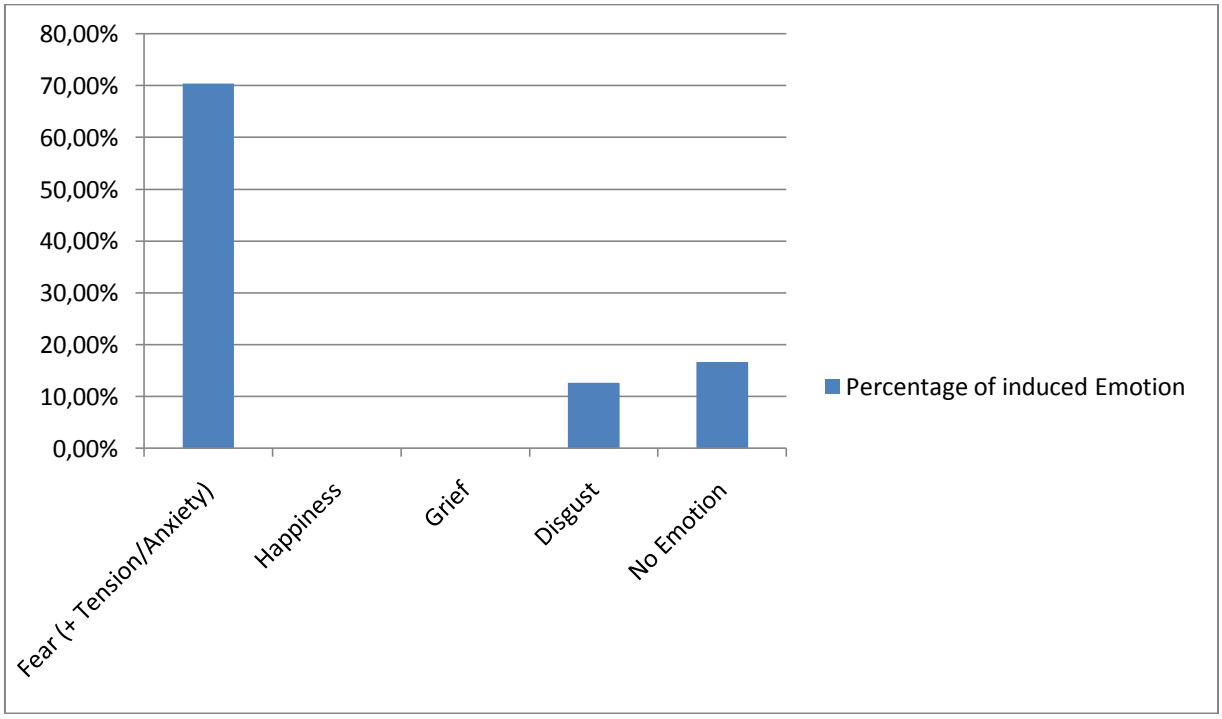


Figure 52 Emotions induced by Film Clip

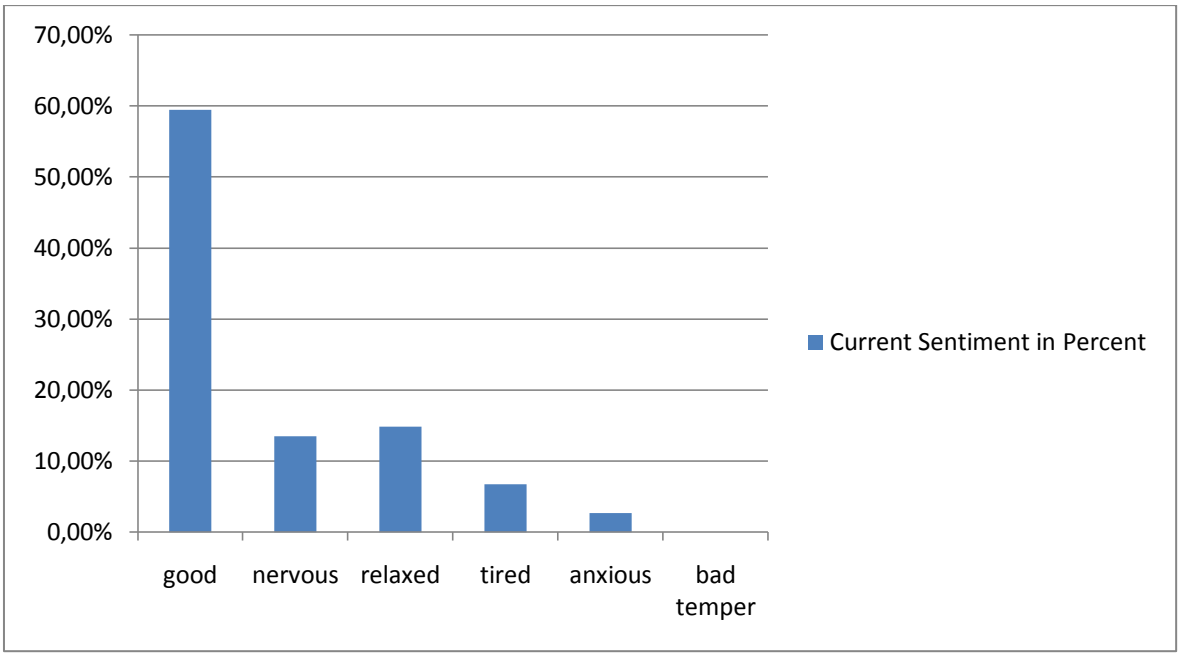


Figure 53 Current Sentiment

Besides the participants' current sentiment, the physical condition judgements was recorded. Here, they were able to choose between whether or not they experience discomforts. If a testee marked yes they were asked to shortly state their medical condition. 83.78% declared they do not suffer from any health problems. From the 16.22% who stated to experience afflictions, one participant ingested calmatives, two had a common cold, five are high-blood-pressure patients and three had problems with their cervical spine. Gathering and evaluating this information might support the assumption of a, by medication, affected operability. Analyzing the video data and the participants' behavior, lead to the conclusion that some discomforts as well as specific medication could affect a person's operability. The testee who ingested calmatives, for example, seemed distracted and agitated. Those who suffer from hypertension did not show signs of nervousness (Figure 54).
However, the physical condition of a testee had no influence on their subjective feeling in respect to their sentiments, which they had to classify in the question before.

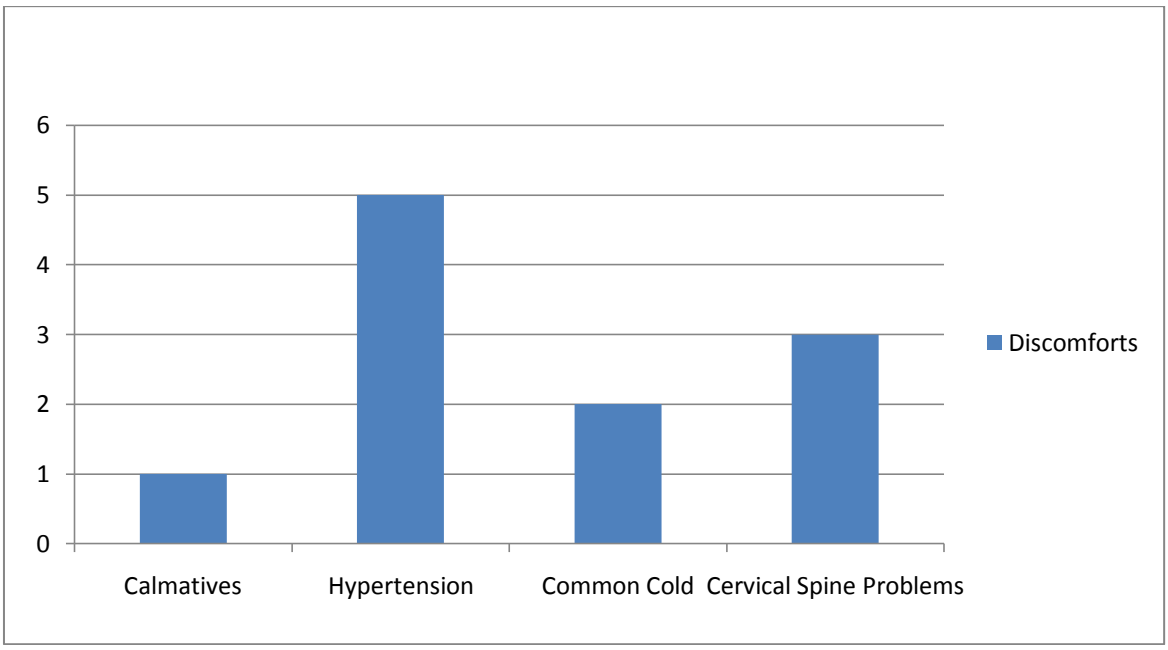


Figure 54 Discomforts Experienced by Study Participants

Regarding the software ergonomic principles due to Nielsen and Shneiderman and based on the ISO 9241-10 standard (see section 6), the application shall be evaluated in the following sections. However, the non-recurring conduct of this usability study does not deliver reliable data regarding memorability, which is therefore not further discussed. The evaluation is executed task by task, to allow a review of all the application's existing functions.

10.1. First Aid Measures

The test participants were asked to open the function "First Aid Measures" and to review the diagram (Figure 55). Moreover they were prompted to give instructions regarding first aid, based on the graphics displayed to them.
56.76% stated that they knew which step, regarding first aid, to perform next at all times. Only 12.16% felt uncertain about the tasks to be performed, 18.92% felt the diagram is not suitable for the task and hoped for more instructions. 63.51% on the other hand declared the diagram suitable for learning, since they immediately understood the proper sequence of first aid measures, which needs to be accomplished in an emergency such as cardiac arrest.

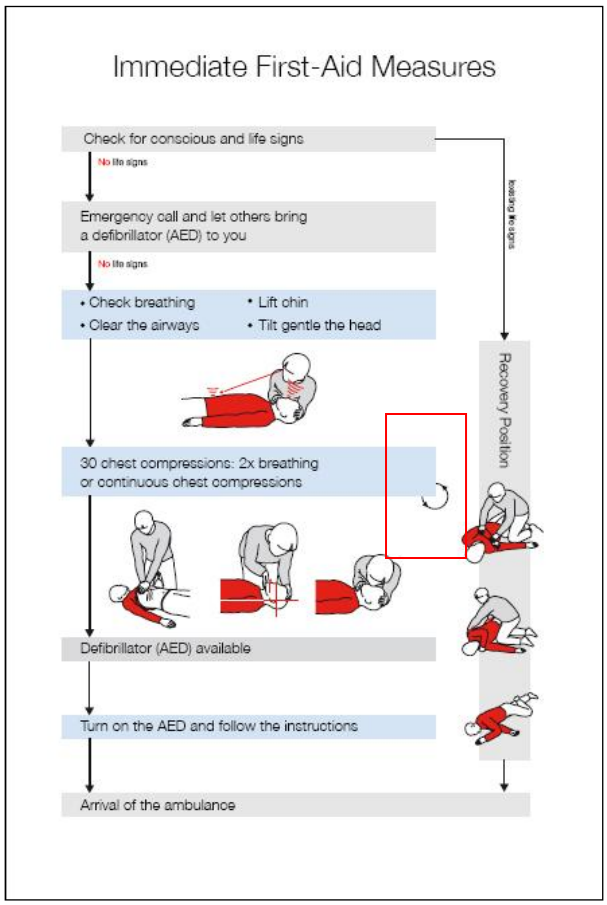


Figure 55 Circular Symbol Representing Performing CPR Continuously

When asked whether they saw the circular symbol in the diagram 63.51% of the participants denied. 20.27% searched for the mentioned symbol on request and found it after an average of 7.6 seconds. Merely 16.22% of the testees detected the circular symbol unrequested, representing the continuous application of CPR (Figure 55).

Several participants used the possibility of verbalizing criticism and/or comments. Twelve participants even stated themselves that they would appreciate language statements or a combination of speech and graphics/text (see section 11). Eight participants criticized the diction used in the German diagram by writing. “Compressions of the thorax” seemed to be a too specified medical term and was even more often commented on. Seven testees stated that they had rather seen more graphics and less text. One of them remarked that “assembly instructions guide primarily via graphics and not via text. If they would consist mainly of text, people would probably not read it.” (quotation testperson No. 47)
Two of the study participants, who are doctors, commented that it is not evident from the diagram’s graphics if the movement of the victim’s head is supposed to be a rotation or a reclination, and it therefore should be made more obvious to ensure correct first aid measures, especially in an emergency (Figure 56).

Figure 56 Reclination or Rotation?

The most distinctive point of criticism nevertheless was the fact that the user has to exit the first aid guidelines in order to place an emergency call. Six participants voiced the idea that the feature of placing an emergency phone call should be integrated directly in the first aid measures' diagram, possibly visualized as a button at the beginning of these guidelines.

The great advantage of the integrated diagram lies in its suitability for learning. Even if no emergency occurs the user of this app is able to open the application in order to review the steps of administering first aid in case a person is either conscious and showing vital signs or if a person is unconscious and showing no vital signs. By always being able to polish up their knowledge regarding first aid measures and hence attaining a learning affect, the user might be able to administer first aid more spontaneous if they witness an emergency, opposed to only relying on knowledge based on a first aid course attended years ago.

10.2. Setting Rhythm to Perform CPR

The App "Defi Now!" disposes of a metronome for setting a rhythm for the first responder to perform CPR, which assures the CPR's effectiveness. During this task, the users were prompted to activate the acoustic signal supporting the pace of chest compressions, and then to stop it.
This task proved to be error-prone. Only 32.43% of the participants recognized the trigger of the metronome immediately as they scrolled to the bottom of the diagram (Figure 57).
40.54% had more difficulties and were able to press the button predefining the resuscitation beat after an average of 6.3 seconds. 5.41% initiated the beat after more than 10 seconds and 22.97% did merely see the trigger after instruction. The implementation did not seem satisfactory to them. Overall 58.11% expressed the desire for more directions given by the application itself. 47.30% presumed the trigger to be placed at a different location, for example directly next to the graphics referring to CPR.

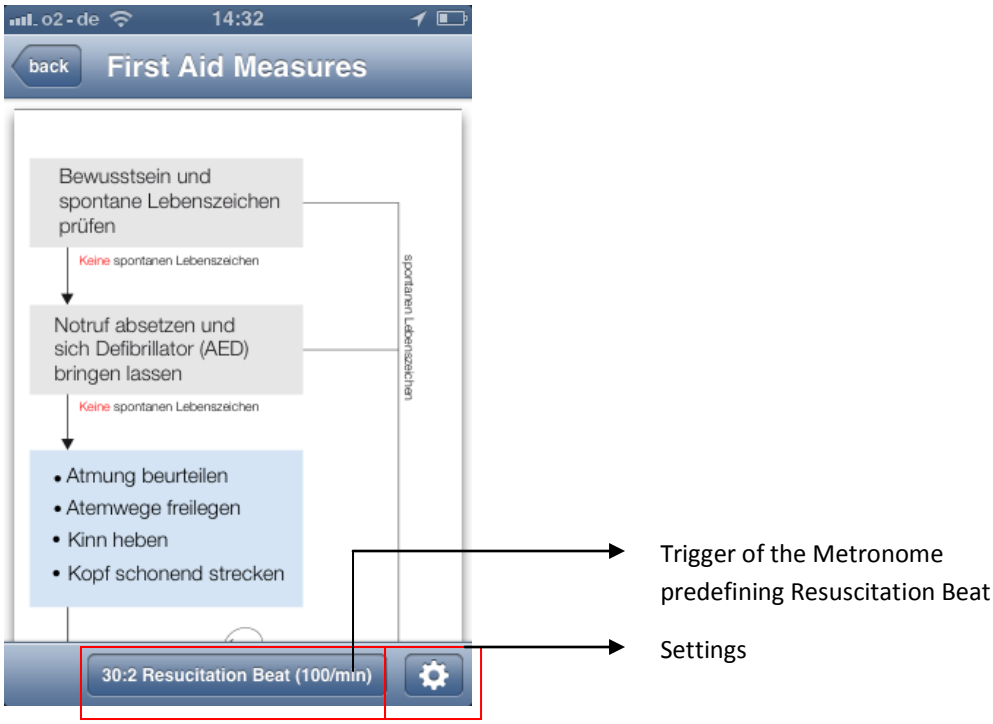


Figure 57 Trigger of the Metronome and Settings Button

If not stopped manually, the metronome sounds repeatedly. When asked to stop the acoustic signal, 47.30% were able to fulfill this task within 3.2 seconds. Nevertheless 41.42% required 5 seconds or longer to pause the metronome. 64.87% criticized the labeling of the button as long as the metronome was active. While the acoustic signal sounds, the button displays a counting operation and no label referring to stopping the beat (Figure 58).

Figure 58 Counting Operation

The participants voiced misgivings regarding controllability, since it obviously takes the user some time to find the trigger setting the resuscitation beat and then to stop it again. Some testees criticized that a user would probably not even suspect a metronome, setting the rhythm for CPR, if they were not aware of such a given feature. Ten testees suggested to highlight the metronome-trigger, for example by labeling it more clearly, setting a different color or adjusting the button's size.

Further they were asked to change the settings regarding the rhythm of CPR, which means the resuscitation beat can either be adjusted to 100 chest compressions per minute without mouth-to-mouth ventilation (100/minute) or to 30 thorax compressions and 2 mouth-to-mouth respirations (30:2). As a study at the university clinic of Tokyo, conducted by Prof. Ken Nagao et. al (2007), demonstrates that cardiac-only resuscitation by first responders is the preferable approach to resuscitation for adult patients with witnessed out-of-hospital cardiac arrest, especially those with apnea, shockable rhythm, or short periods of untreated arrest.

47.30% declared they recognized the button referring to the resuscitation beat's setting immediately (Figure 57). 52.70% experienced difficulties fulfilling the task of changing the rhythm of CPR. 26.12% of the participants held the opinion that this facility for alteration was not relevant, whereas 74.32% acclaimed this option. Six participants criticized that the settings' button was indistinct and desired a more obvious labeling, for example a written identification of the buttons' function.

Three usability study participants (medics) remarked that the duration of time scheduled for mouth-to-mouth ventilation, which is set to 3 seconds, should be prolonged. In their opinion 3 seconds was not enough predefined time to perform mouth-to-mouth ventilation and return to their initial kneeling position to perform CPR. If these actions would take longer than 3 seconds, they would not be able to keep up the rhythm set by the metronome and might get confused because their personal rhythm would not be equal to the metronome anymore. This might entail the risk that they delay their performance of CPR until the next cycle of 30:2 begins, an action sinister to the person suffering from SCA.
Several participants (medical personnel and laymen) remarked that the facility of alteration might be obstructive and counterproductive. They argued that a user might be overchallenged by the options of cardiac-only resuscitation or CPR with mouth-to mouth ventilation in an emergency. For them a precise instruction preinstalled in the application would be preferable.

Another important weak point was detected by one user. He opposed to the fact that the metronome stops as soon as the user quits the menu section “First Aid Measures” and for example returns to the map searching for an AED. Unless another user has the same application installed on his smartphone for seeking an AED, the first responder does not have the possibility to adjust his CPR to the pace preset by the metronome. They then might also not be able to keep up the rhythm, which might entail severe consequences, as stated before.

The task of setting the rhythm to perform CPR brought several problems to light concerning the operability. Several participants were not satisfied with the implementation of features such as the labeling of the buttons referring to the starting/stopping of the resuscitation beat and the settings concerning the rhythm for performing CPR. They evaluated these features as being not self-descriptive and expected a clearer labeling for better usability. Moreover they were not satisfied with the controllability since it took them some time to find the trigger starting the metronome setting the resuscitation beat. They voiced that in an emergency time would be wasted searching for those precise functions and remarked that they should be implemented more eye-catching and distinctly comprehensible.

10.3. Displaying General Information

The App “Defi Now!” allows the user to gain information about its development and from where data is retrieved. The participants were asked to have the general information indicated to them.
Because the testees accomplished the previous task in the application’s section regarding first aid measures, they had to navigate via the back button to the main menu and locate the information-button (Figure 59). 33.78% detected the information button on sight, another 22.97% of the participants spent less than 5 seconds searching for the inquired function. 29.73%, equaling 22 test participants, did not recognize the button by themselves.
When verbalizing criticism, 11 participants stated that they thought a more distinct design of the button would have been helpful to recognize the button at all.

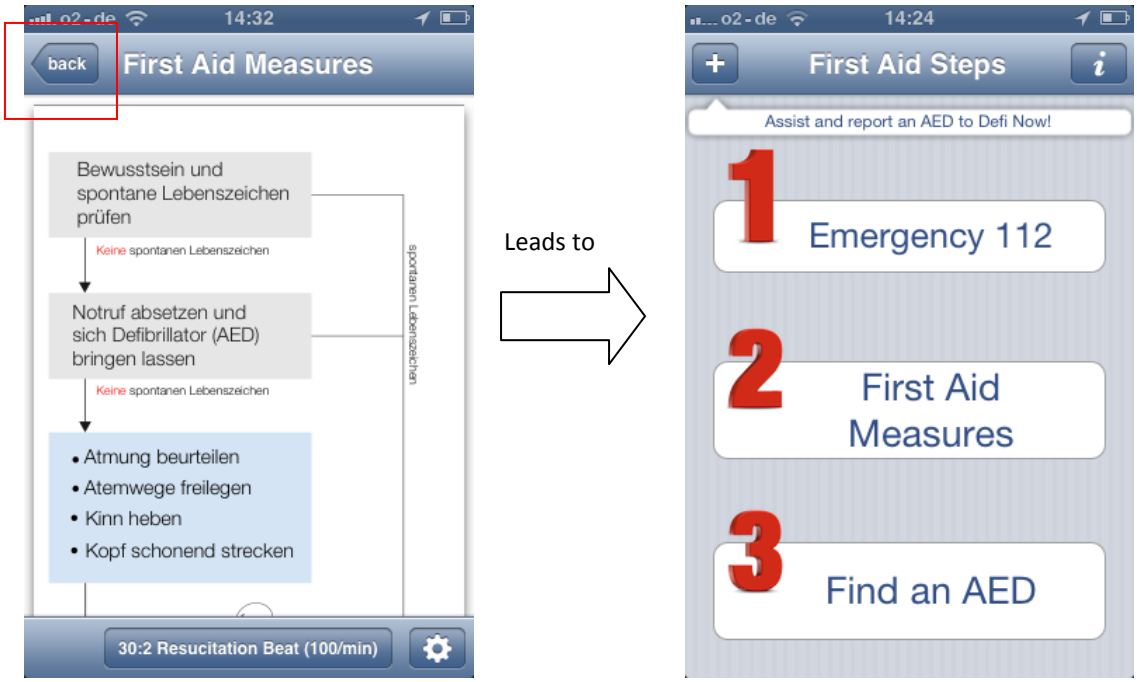


Figure 59 Navigating Via Back Button to the Main Menu

Aiming at the desired principle of consistency in software ergonomics to ensure a fluently navigation through the application, the testees were asked whether they immediately identified the back-button, leading to the main menu. 55.41% stated that they immediately recognized the back-button, which can be seen in the left image of Figure 60. Only 24.33% declared that they expected reliability. In their opinion the back button should be positioned at the top of the application, aligned to the left. Further they stated that the chosen location is not conformal to their expectations.

Fulfilling the principle of consistency the back-button[5] should have been located left-aligned at the top of the application, just as all the other back-buttons used and placed in the app (Figure 60). These results might prompt that the principle of consistency is not that important to mobile device users. Nevertheless it is proven that the principle of consistency ensures maximum convenience in use, independent of the field of application (Horn), which shall be displayed during the suggested improvements in section 11.

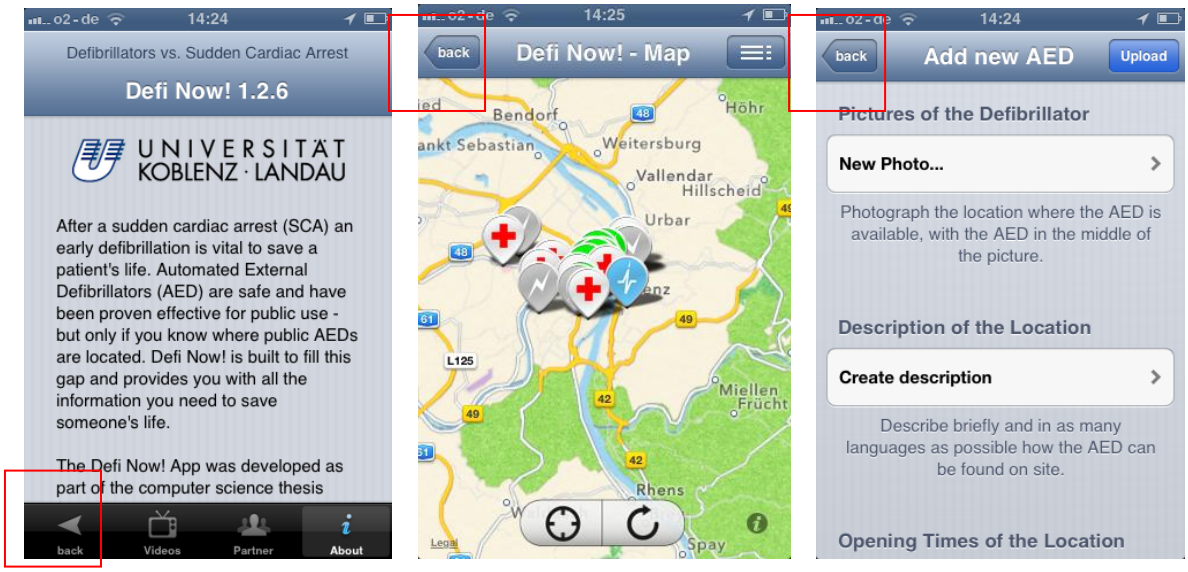


Figure 60 Inconsistent Design Regarding the Back Button a) Design of the Back Button in the General Information as Tab Bar b) and c) Design of the Back Button in the Rest of the Application as a Menu Button on the Upper Left

[5] (Inc., 2010) iOS UI Element Usage Guidelines regarding the design of buttons in a user interface

After exploring the application “Defi Now!” during the last three tasks the users were able to record a learning effect regarding the position of the back button as a menu button on the upper left. But the different position and design of the back button in the general information as a tab bar button led to irritation on the users’ behalf (Figure 60a). As mentioned before, about half of the participants were able to locate the back button immediately, whereas the other half had difficulties. They voiced that the changed position of the back button, as well as its design as a tab bar button, was not conformal to their expectations.

10.4. Adding a New AED Location

The application „Defi Now!“ comprises the possibility of adding a new AED location to the database. Therefore the user has to press the “add-button” on top of the main menu’s page (Figure 61). Adding a new AED location was examined regarding the learnability, the circumstance, how easy it is for users to accomplish this task the first time they encounter the design. 10.81% noticed the button implemented for this function within few seconds and managed to add a new AED location easily. Another 10.81% searched for more than 5 seconds until they recognized the balloon with the text “Assist and report an AED to Defi Now!” referring to the “add-button” (Figure 61). When asked if the balloon adverting to the addition of a new AED was immediately recognized 66.21% denied.
27.03% of all participants stated that it was very hard to discern this feature embedded in the main menu. Six testees voiced that highlighting the balloon with a contrasting color might be helpful to realize the function of adding a new AED more quickly. Several study participants claimed they actually saw the balloon, but did not read its text and therefore did not bestow consideration upon it.

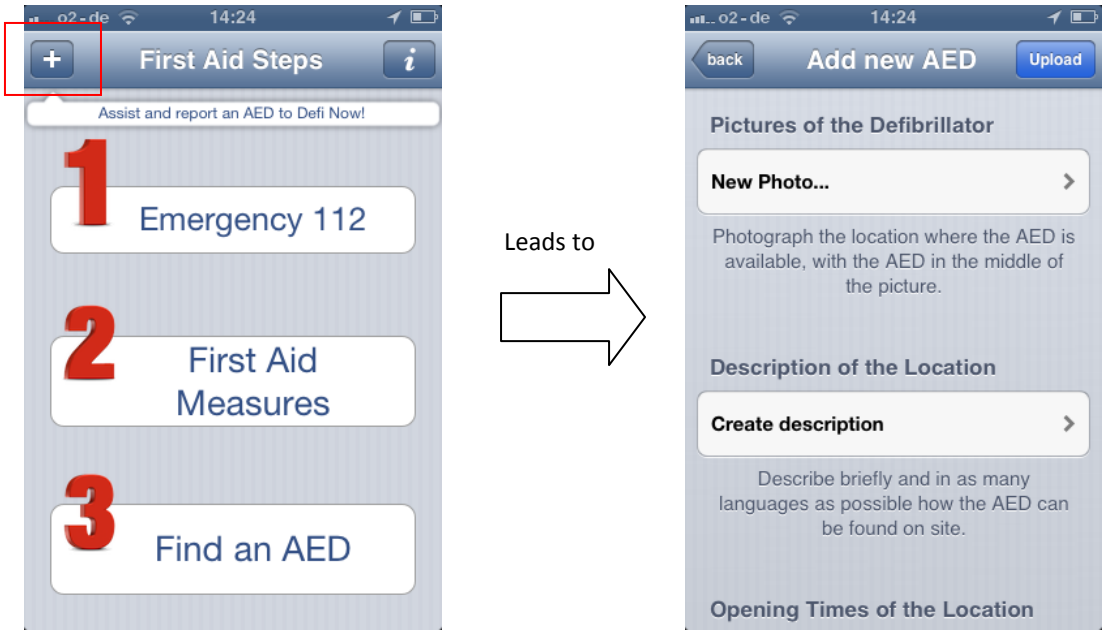


Figure 61 Add a New AED

29.73% encountered more problems fulfilling this task. They searched for a long time (more than a minute) and often assumed this feature within the menu of the map, because the AED locations are displayed within the map itself. All other features concerning the map and AED locations are visible in the application's third segment "Find an AED". Therefore it seemed obvious to them that adding a new AED would also be performed in that section.
33.78% were not able to add a new AED location by themselves and needed assistance.
Sixteen users stated that this function should be added to section three "Find an AED". Eight test participants criticized that adding a new AED should be implemented at the end of the application, as an own fourth section. When explicitly asked whether or not the users expected this function within menu section 3 "Find an AED", 70.71% answered in the affirmative. Only 21.26% of the testees did not expect adding a new AED in section 3 of the app.

The argument shall be permitted that an addition of a new AED is not performed during an emergency and therefore is time-independent. Nevertheless this function should be implemented suitable for the task, self-descriptive and as a result satisfactory to the user. Personal experience has shown that people are helpful as long as something runs smoothly. However, if problems occur or something can only be performed with great difficulty they refrain from helping, a fact that can also be derived from the bystander effect. (Bibb Latané, 1968) Therefore to encourage people to actively participate functions need to be implemented with high controllability.

Summarizing the results yielded during the task of adding a new AED location it became clear that this function did not seem self-descriptive to the test subjects. The “add”-button was not recognized in its function and therefore merely 10% of all the testees were able to fulfill this task. The majority of study participants favored a clearer labeling of the feature of adding a new AED. Moreover the position of the “add”-button yielded problems. Twenty-four participants voiced that the function of adding a new AED should have been implemented at a different position and stated that the current position at the upper left was not conformal to their expectations.

10.5. Displaying Table View of Given AED Location

The user of “Defi Now!” can have the information concerning the AED locations displayed to them as a table view or as an interactive map (Figure 62). 40.54% of the participants stated they assumed this function within the menu section of adding a new AED location. 54.06% supposed the table view in section 3 (find an AED), in which the map is positioned as well.
This ambiguous distribution of opinions exhibits a deficit regarding the implementation based on the conformity of user expectations. Concurrent features, such as display of map and table view, both including information concerning the stored AEDs, should be designed coherently in reference to the locality principle. (Horn)

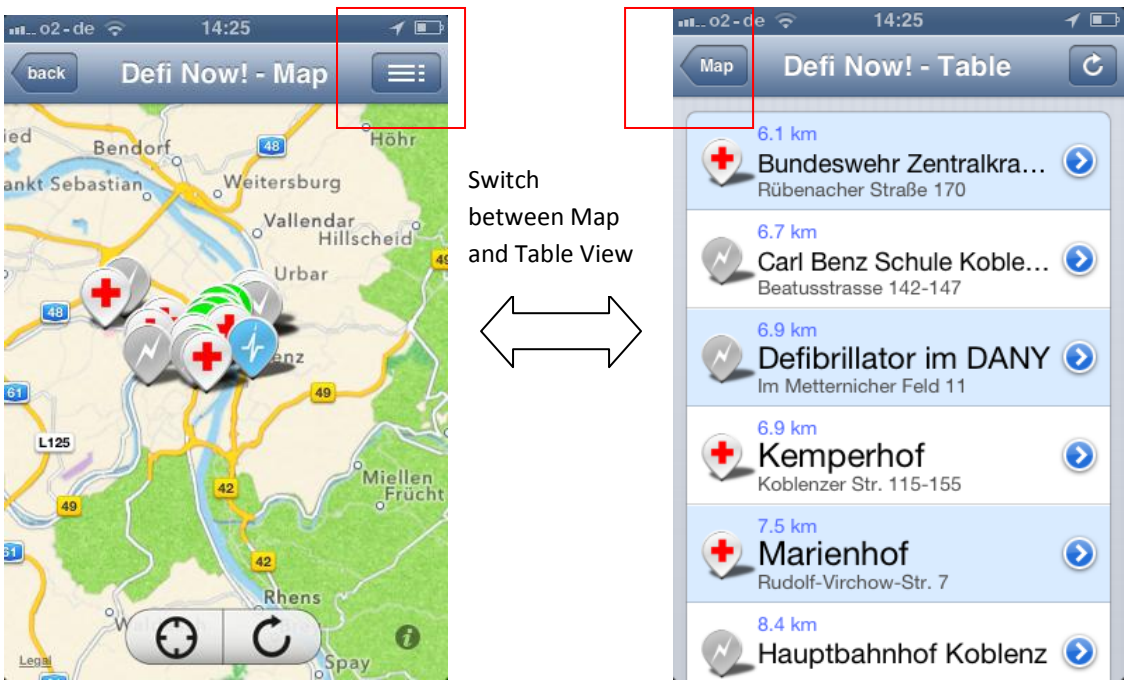


Figure 62 Information Displayed Via Map or Table View

Those who assumed the table view within the section “Find an AED” had no or few problems recognizing the inquired button, which is reflected by the percentages. 48.65% identified the button immediately as soon as they navigated to the embedded map. 27.02% experienced few problems because they did not associate the button’s icon with the table view function. 24.32% did not fulfill the task of opening the table view at all, because they also did not comprehend the given icon (Figure 63).
Seven study participants commented on the table view button. In their opinion a written labeling would have marked the function clearer. Three testees voiced the idea that the table view might be displayed before revealing the map. This might facilitate the understanding of which AED location is the most nearest, legible by the distance value.

Figure 63 Table View Button

Evaluating the results yielded during the task of displaying the table view of given AED locations it became clear that the positioning of this function was not conformal to user expectations as stated before. Nearly 41% expected this function to be located within a different menu section. Again, the iconic design of the table view button led to comprehension problems on the users’ behalf. About 51% remarked that the icon on the button was not self-descriptive and indicated they would favor a more precise labeling of this function as well.

10.6. Categories of AED Icons

The pins on the map, displaying an AED, are depicted with different colors. The pin's color defines whether the AED location is confirmed (green), unconfirmed (gray), or placed in hospitals or in places where medical staff is available (white with red cross) (Figure 64).

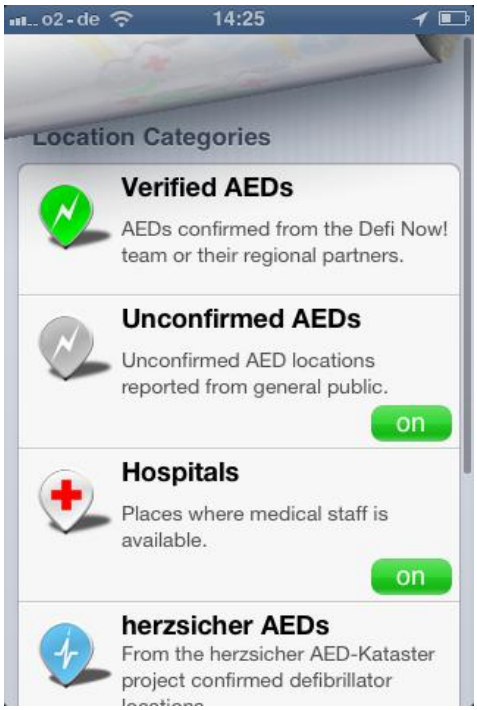


Figure 64 Categories of AEDs

In this task, the study participants were prompted to indicate the different categories of AED icons (Figure 64). Merely 21.62% were able to complete this task without or with minor problems. They stated they recognized the "i"-button in the lower right corner on the map (Figure 65). 78.38% experienced difficulties fulfilling this task, though.
79.66% of the testees stated to have tried to press the icons on the map multiple times in order to have the desired information displayed to them. 68.91% of all study participants searched for information regarding the AEDs' categories at the upper buttons (Figure 65).

54.06% pressed the lower two buttons for gathering information on the AEDs' depictions (Figure 65). Those who pressed the lower two buttons (reload and return to user's location) remarked they would have appreciated a labeling of the function buttons.

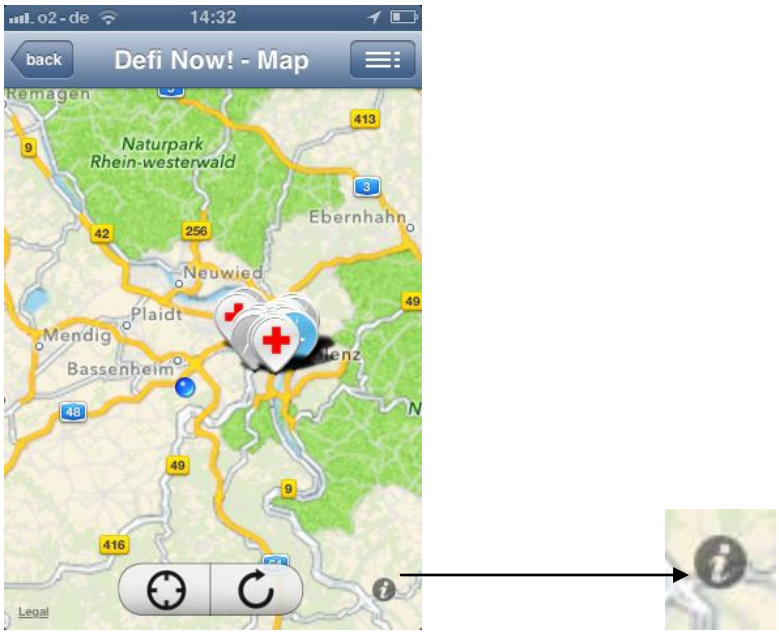


Figure 65 Information Button Embedded in the Map Leading to the Categories of AEDs

Seventeen testees stated they did not find the information button leading to the categories of the different AED icons by themselves. They suggested the “i” (Figure 65) to be displayed in a different color, which might be more conspicuous. Furthermore they proposed the information to be attained via an implemented button, comparable with the information button in the main menu. This might also ensure consistency and would promote the conformity of user expectations.

After the categories of AEDs were revealed to them, the users were asked to close this information site again. 51.35% chose the “close-button” to return to the map again and 48.68% selected the alternative by flipping the turned-up page down (Figure 66). Some test participants remarked that offering an alternative for the close mechanism seemed to be too much. Eight participants stated it was not easy to recognize the close-button because they did not expect to have to scroll down further and it therefore seemed to be hidden to them. Overall, the study participants fulfilled this action within 3 to 27 seconds.

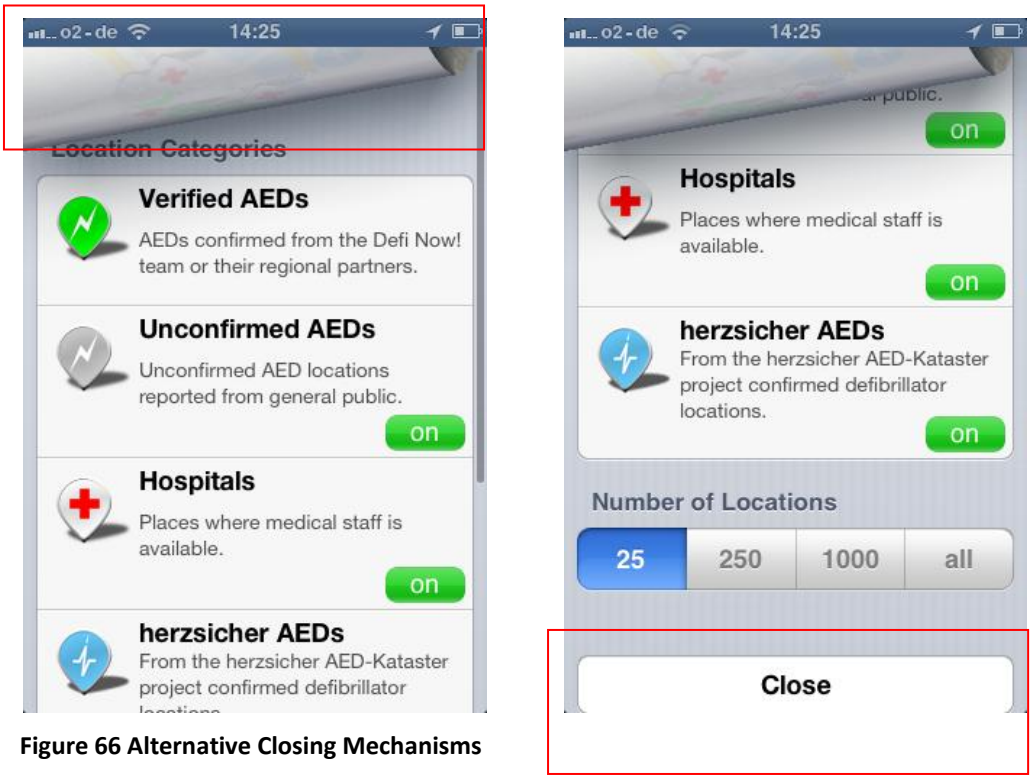


Figure 66 Alternative Closing Mechanisms

Here again, time is not such an important factor, since probably no first responder is interested in knowing what the different icons, depicting an AED location, mean, as long as they are able to retrieve an AED from one of the given locations.
Yet, the loading time of the server is severely time-dependent. A big problem during this study was the time needed for the AED locations to be loaded on the map. Dependent on the user's position and the available cell coverage the loading time differed from 2 seconds up to 1:30 minutes. Sometimes the map could not even be displayed at all because of its dependence of cell coverage. In an emergency essential time would be wasted. For improvements on this behalf see section 11.

Summarizing the obtained results yielded problems concerning the recognition of the information button located in the map, leading to the explanation of the different AED icons' categories. Here again, the button was not realized due to its fading into the map. The participants voiced a clearer distinction of the button would lead to recognizing the "i" generally as a button. The users rather expected to obtain information about the different AED categories by simply clicking the icons, which led to unintended effects as revealing the AEDs exact address. This feature did neither seem self-descriptive to the majority of the users, nor did it seem suitable to the task to them. Furthermore the two options for closing the information regarding the AED categories by either flipping the page or clicking on the "close-button" did not seem suitable to the task. One closing mechanism seemed fully sufficient to the participants and offering several options for the same function merely led to irritation.

10.7. Displaying Information of a Specific AED Location

During the task of displaying information of a specific AED location, the participants were encouraged to choose an AED arbitrarily and have information, concerning the exact address, displayed to them. After fulfilling this action, they were prompted to close the displayed information again. 89.19% tapped on one AED location depicted by a pin and received information regarding the address. 10.81% did not fulfill the task and did not manage to open the required information (Figure 67).

Figure 67 AED Location with the According Address

40.54% tapped on the pin once again trying to close the displayed information-balloon. 83.78 % of them complained that the subjacent pin became active as they wanted to hide the information-balloon (Figure 68). To ensure correct handling and precise selection, the user must scale the map, by zooming into the map, until the pins do not overlap anymore. Seven testees were not able to zoom into the map or were not aware of this option.

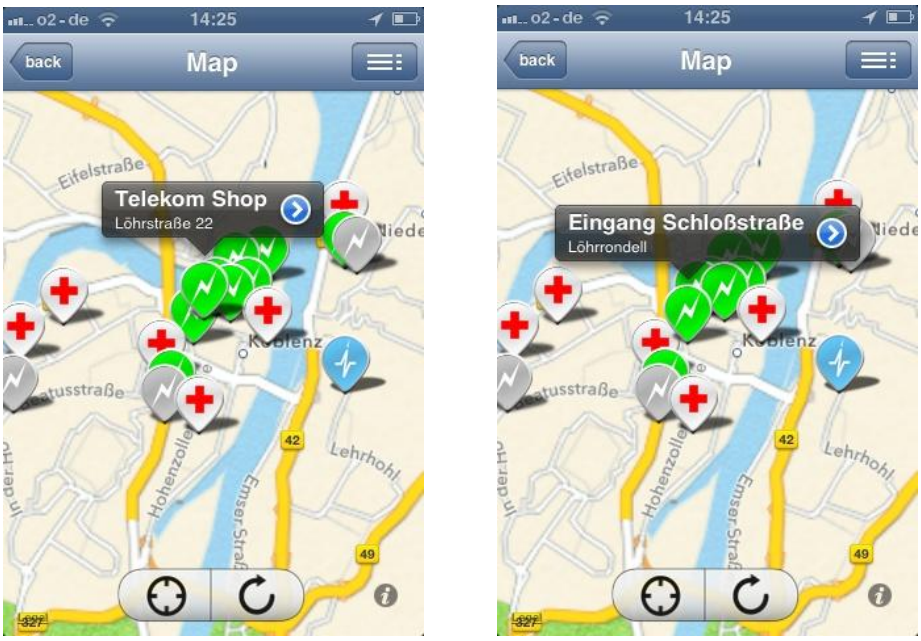


Figure 68 Tapping on the Pin Once More Activates the Subjacent Pin

20.27% of the testees managed to close the information with the implemented and intended mechanisms by clicking on the balloon once again. 35.13% stated they tapped on the blue arrow in the grey balloon providing the address (Figure 68). This only prompted additional information regarding the AED to be opened (see Figure 70). Clicking the map to close the appeared balloon (performed by 4.06%) did not prove to be error-tolerant. Half of the time the users tapped onto the map, the whole application was closed automatically. The other times the users clicked on the map nothing happened because not sensitive panes were embedded into the map, other than the AED icons and their coherent information-balloons. 81.08% of the study participants remarked they would have appreciated the generally known and utilized “x” to close the information-balloon (Figure 69). A great number of study participants criticized the inconclusive design for selecting and closing this function.

Figure 69 "x" Generally Utilized for Closing an Application

For task fulfillment the map had to be opened by the testees. During this action the problem of having to load all AEDs into the map persisted. Without a (wireless) internet access this action could not have been accomplished, because no defibrillator locations would have been displayed on the map. This problem is in great need of adjustment to ensure correct guidance in an emergency and shall be discussed in section 11.

Concluding the obtained results during the task of displaying information of a specific AED location the users' expectations were not fulfilled. Merely about 20% of the test participants were able to close the information bubble with the intended mechanism by clicking on the balloon. By clicking on several different areas for closing the balloon, as described before, the majority of the users did not obtain the aimed-at result. Clicking on the map for closing the balloon was even not error-tolerant because in nearly 50% of this action the whole application was shut down.

10.8. Displaying Detailed Information of a Specific AED

The application "Defi Now!" entails the possibility of displaying additional information of an AED location, which is more detailed. Besides the address, it consists of opening hours, directions to the location and pictures additionally describing the AEDs position.
The test participants were requested to open the more detailed information regarding an AED of choice.
68.92% stated to have tried to complete this task by tapping on the information-balloon. The assumption seems natural that this relies on the conduct with hyperlinks or hypertext. The user is accustomed to tapping on a link for navigation on websites, and therefore redirection via link-clicking is conformal with user expectations. (Hollenstein, 2009) (Moser, 2009)
43.25% of the testees provided the information that they tapped on the blue arrow in the information-balloon. Digital recordings via camcorder show a slight different behavior. Every single study participant first clicked on the grey information-balloon and, after not achieving the required result, then tapped on the blue arrow. Questioning why they tapped on the information-balloon first yielded the same answer. All of the participants voiced they assumed a hypertext link embedded in the address line displayed in the information-balloon. Therefore redirecting the user via click on the blue arrow does not provide conformity with their expectations, nor does it seem to be self-descriptive (Figure 70).

Figure 70 Redirection to Additional Information from the Map by Clicking the Blue Arrow

Another malfunction was reported by the test participants. When seeking additional information via the table view instead of the map, the user must tap on the address for additional information, instead of clicking the blue arrow for redirection (Figure 71). Therefore, redirection on the map and the table view are of inconsistent design and need to be adjusted either way to ensure efficiency. Once the user has learned the design, they should be able to quickly perform tasks concerning the same procedure. With two different actions having to be performed for completing the same action it cannot be ensured that the user gains controllability concerning redirection. The way it is now implemented, it does neither enable the user to record a learning effect nor is it conformal with their expectations.

Figure 71 Inconsistent Design Regarding the Redirection

10.9. General Appearance and Navigation

This section comprises the assessment of the study participants regarding the application's general appearance and its controllability measured by the efficiency of the user to navigate through the app. Therefore the users were prompted to return to section 2 (First Aid Measures) from their current position in the app. From every other section the user has to navigate via back buttons to the main menu and then simply press the button "2 First Aid Measures" (Figure 72).

Figure 72 Navigating from e.g. the Map to the First Aid Measures

85.13% had no difficulties performing this action indifferent to their current position. Because of all the previous tasks, a learning effect could be recorded and the participants were able to navigate through the app via the now familiar back buttons. 14.86% of the testees could not navigate through the app as easily. Although they were also familiarized with the design during the previous tasks, they were not able to fulfill this task promptly.

More than 65% of the study participants stated to be content in terms of the app's controllability and structure. 55.40% indicated that they were able to easily navigate through the app in general. 22.98% showed signs of difficulties and often forgot which path leads to the next desired function. 21.62% of the testees managed to fulfill the tasks, but not without reflecting. On the contrary to the ones content with the application, 25.68% stated that the application seemed to be impractical to them in respect of its operability and even 32.88% held the opinion that the structure of "Defi Now!" is confusing.

Moreover when asked whether the application “Defi Now!” seemed clearly structured 60.81% of the study participants affirmed. 16.22% uttered slight doubts and 22.97% were not content with the application’s design at all. The next assertion confirms the tendency of the user’s likings even more. Although 60.81% of all test participants stated they were satisfied with the function descriptions, 63.51% of all testees anticipated a more precise phrasing of given functions.
In line of this study the participants were asked to indicate their personal opinion regarding the application’s different designs for the operating systems of Android compared with the one for iPhone (Figure 73). 62.16% of the testees favored the design of the Android operating system, while 28.38% preferred the design utilized for the iPhone. 9.46% could not denote a precedented design.

The emphasis of choosing the Android’s design was justified based on the internationally established depictions by 31.08% of the study participants. They argued that the icons utilized are more memorable and recognizable. Six participants added that the green color, used as background, is more pleasant. Five participants stated that the Android version of “Defi Now!” is structured more clearly, whereas seven testees held a different opinion. Nine test participants remarked that the iPhone version of “Defi Now!” convinced them with its brightness due to the white background color. On the one hand the structure of the iPhone was realized as an explicit guideline, which suited four participants. On the other hand it deterred seven testees because they identified the design as an inflexible step-by-step structure, predetermining the next step and not allowing them to navigate through the application freely. When urged to create a new appearance for the application, 85.14% suggested a combination of both designs; a lighter one with icons depicting the single sections instead of numbers.

Figure 73 Appearance of "Defi Now!" of the iPhone-Version (Left) and Android-Version (Right)

10.10. Conclusive Questions

The last part of the questionnaire consists of the acquisition concerning the distribution of smartphones regarding the participants' age. Overall 63.51% of the study participants own a smartphone. The allocation in Figure 74 shows that the vast majority belonging to the age group of 30-45 and younger own more often smartphones compared to participants of 46 and older. The testee group of 46-60 year-olds is almost equally divided into smartphone users and those owning a feature phone, while among the group of over 60 year-olds only two testees own a smartphone. Other studies also demonstrate the trend of smartphone distribution. (Nielsen)

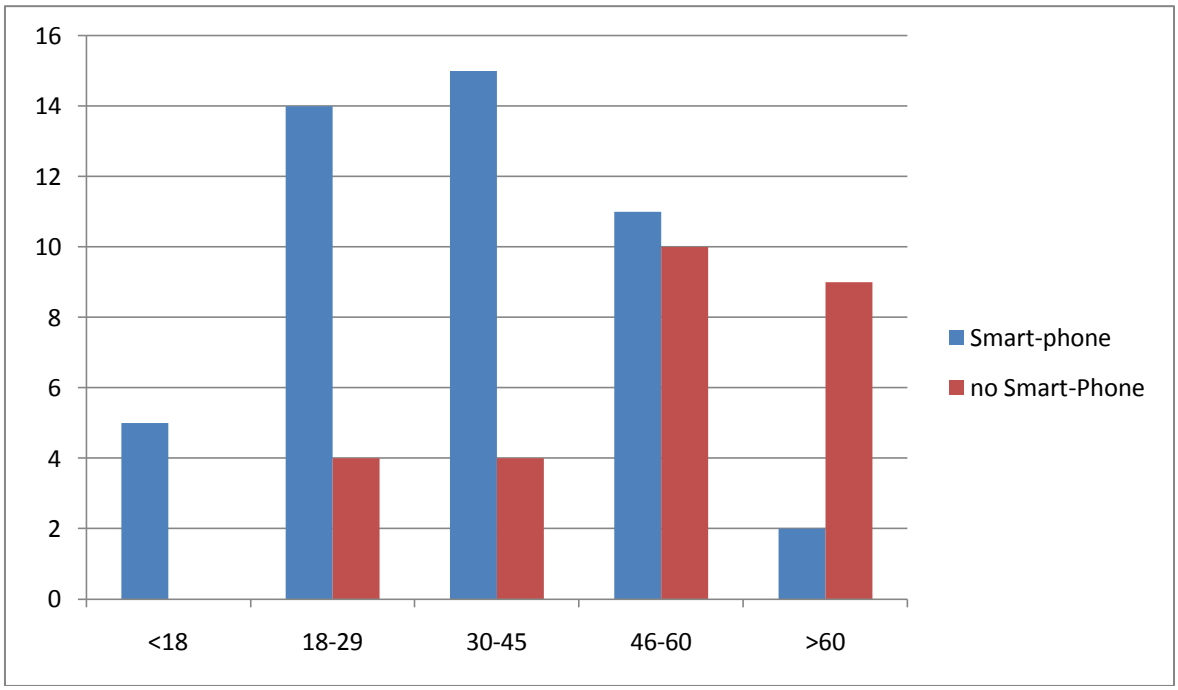


Figure 74 Distribution of Smart-Phones with Respect to Age

Further the study participants were prompted to state their opinion regarding general language-based systems (Figure 75) and in particular language statements embedded in the application "Defi Now!"(Figure 76). 62.16% uttered that language statements are helpful, most of them thinking of a navigation device and its language statements. Female participants appreciate language statements more than male testees, of which 9 stated they even feel disturbed by language statements. Fifteen study participants felt indifferent regarding the utility of language statements.

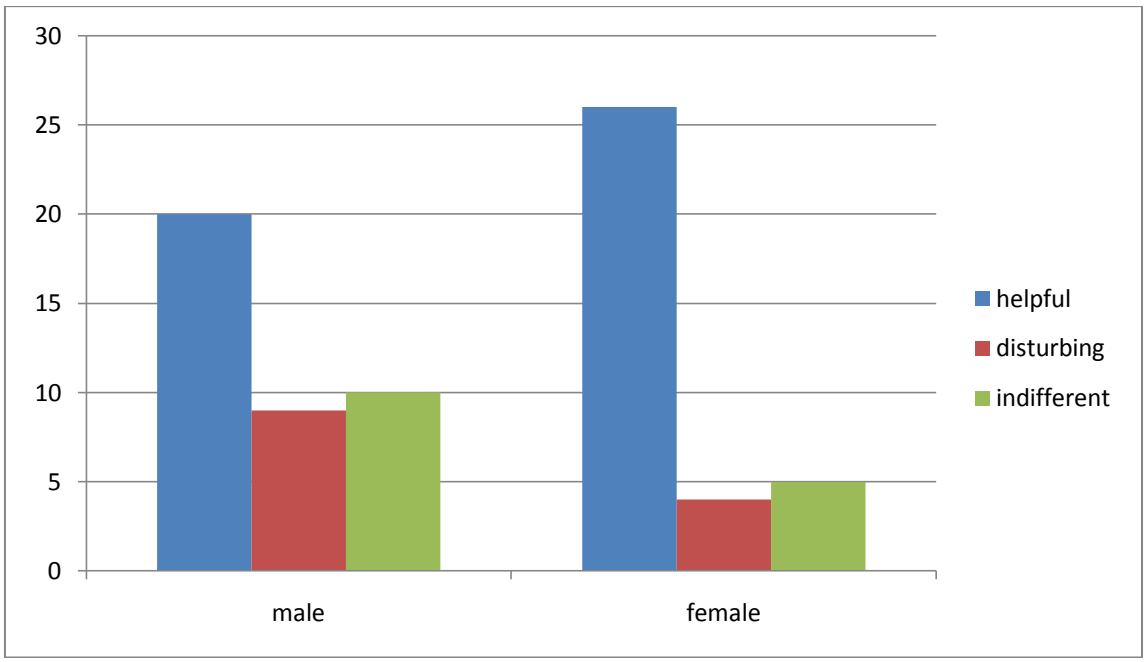


Figure 75 Participants Judging Language Statements in General

Nevertheless when asked if the first aid application "Defi Now!" would benefit of a language-based system, 68.92% of the participants clearly stated that it would. Of these 51 testees approving language statements, 26 are female and 25 male. Twelve participants objected the utilization of language statements in this application, of whom nine are male. 14.86% felt indifferent regarding the embedding of language statement in the app "Defi Now!", the majority of them being male as well. This conducted usability study delivers results displaying that male users are more hesitant and skeptic towards language statements.

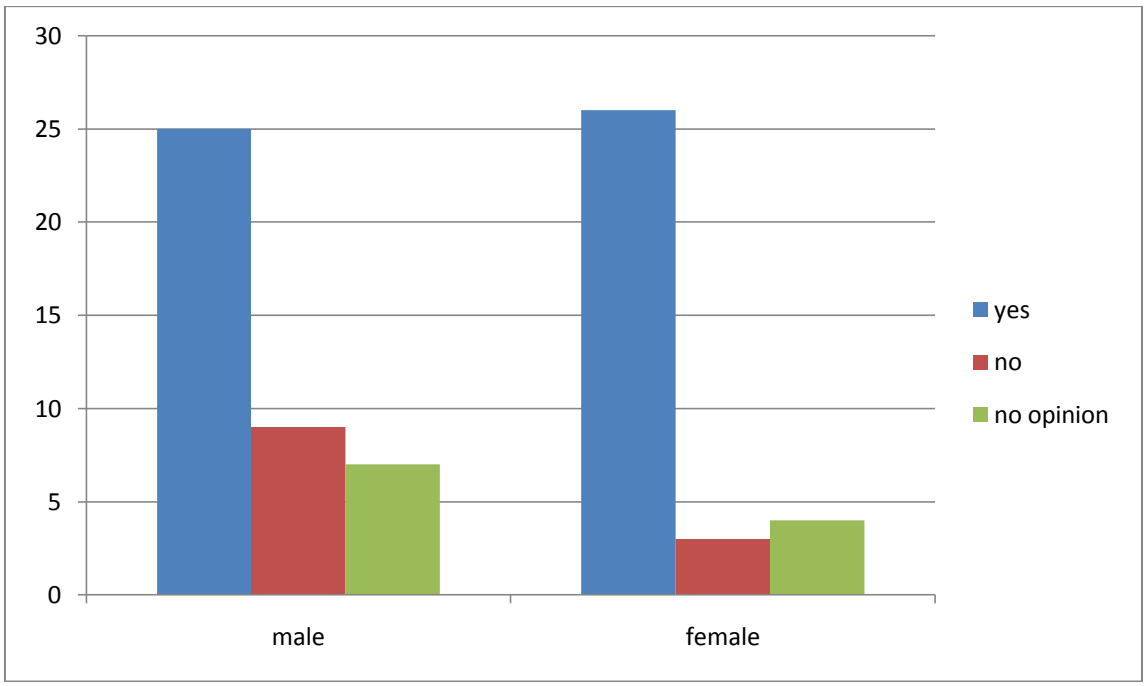


Figure 76 Participants Judging if Language Statements Regarding This App Are Helpful

The participants were also prompted to judge if the application would provide assurance when administering first aid in an emergency. 70.72% agreed that "Defi Now!" is a great addition regarding guidance in case of witnessing an emergency. 6.76% stated that the app might distract a first responder as long as they are not acquainted with the app itself (Figure 77). They argued that the user might be irritated by the graphics or not yet fully sophisticated features.

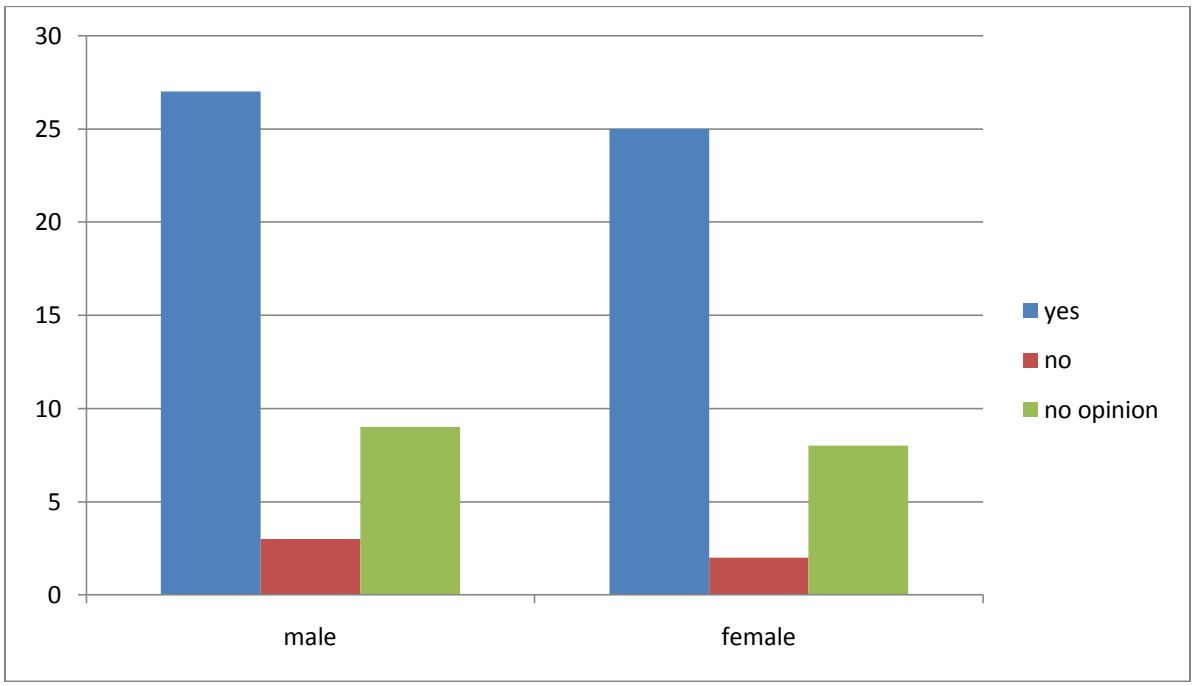


Figure 77 Participants Judging if the Application Would Provide Assurance When Administering First Aid in an Emergency

To acquire information how up-to-date their knowledge concerning first aid measures are, the study participants were asked to provide information regarding their last attended first aid course. Three participants stated they never attended such a course, two of them being under the age of 18. 33.78% of the testees completed a first aid course less than 3 years ago. 8.11% indicated their last course was attended 3-5 years ago, and 6.76% declared having attained one 6-10 years ago. The vast majority claimed they were not instructed to first aid measures for more than 10 years (Figure 78).

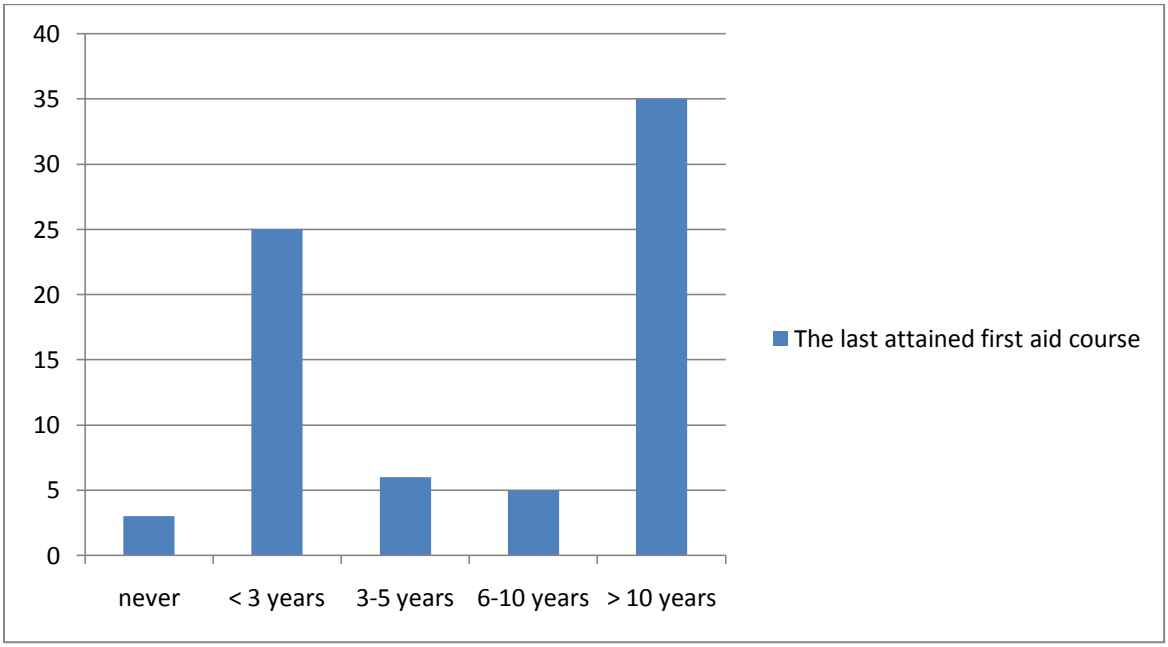


Figure 78 Time Passed Since the Last First Aid Course Attained by the Test Participants

The last question referred to the participants' opinion, whether they would feel more secure knowing that people other than medical personnel could administer first aid based on the app. 74.32% indicated they would actually feel more secure if bystanders were able to perform CPR/ first aid and would be encouraged to help due to the application. 22.97% had no opinion on this aspect. Hereby obviously more male participants held back their opinion. Merely 2.70% denied feeling more secure regarding the receipt of correct help when suffering from a sudden cardiac arrest (Figure 79).
Summarizing the individually voiced comments, the study participants agreed that "Defi Now!" is a very helpful and useful smartphone application, which is in need for optimization to assure a better usability. The next section comprises suggested improvements, displayed by mock-ups, in terms of the points of criticisms denoted by the testees.

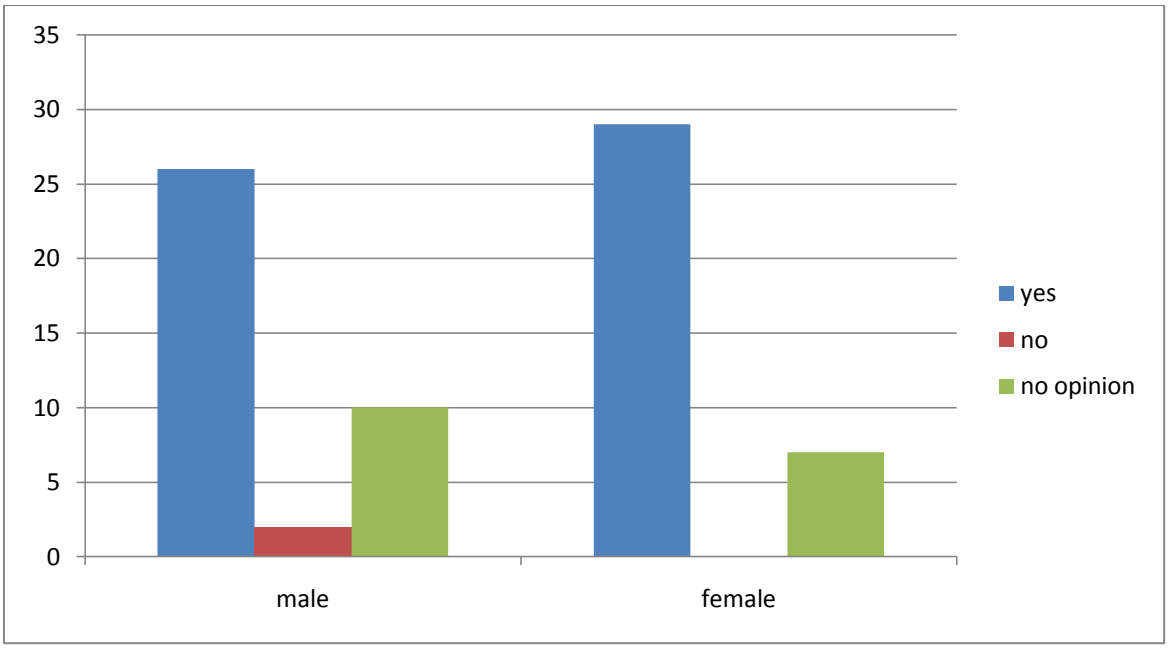


Figure 79 Participants Reflecting if They Would Feel More Secure Knowing That People Other Than Medical Personnel Could Administer First Aid Based on the App

The following table shall give an overview of the discussed difficulties and severe problems with respect to the obtained usability study results. Also, references regarding the improvements based on the test results may be inferred from Figure 80.

Section	Positive Statements	Experienced Problems	Reference to Improvements
10.1 First Aid Measures	Learning effect by viewing graphic concerning first aid measures	-Labeling of repetition symbol regarding the administration of CPR	See section 11 page 96
10.2 Setting Rhythm to perform CPR	_	-Labeling of the buttons “Resuscitation Beat” and “Settings”	See section 11 page 96
10.3 Displaying General Information	_	-Inconsistent design of back buttons - Information button not self-descriptive	See section 11 page 92
10.4 Adding a New AED Location	_	-“Add” Button not self-descriptive -Position of “Add AED”-Button	See section 11 page 104
10.5 Displaying Table View of Given AED Location	_	-“Table View” Button not recognized -Table View expected within a different menu section	See section 11 page 102
10.6 Categories of AED Icons	_	-“i” button was not recognized - too many close-mechanisms	_
10.7 Displaying Information of a Specific AED Location	_	-closing the balloon -clicking on the map not error-tolerant	See section 11 page 100
10.8 Displaying Detailed Information of a Specific AED	_	-Hypertext/-link behavior was expected -Inconsistent redirection of “blue arrow” in table view compared to “blue arrow” in address-balloon on the map	See section 11 page 99 and page 102
10.9 General Appearance and Navigation	-Clear structure -Controllability	_	_

Figure 80 Summary of Previously Discussed Problems Concerning the Existent App "Defi Now!" with References to Improvements

11. Suggested Improvements Displayed by Mockups

In terms of the implemented features and their approval by the study participants, the application “Defi Now!” seems to be well-engineered. Therefore the suggested improvements are based on the results yielded by the usability study, which are summarized in Figure? and the software ergonomic principles, the latter ensuring an optimized usability.
For redesigning the existent app “Defi Now!” the mockup tool “Balsamiq Mockups” by balsamiq[6] was utilized. Mockups are suitable for creating a model of a device, used for e.g. demonstration and design evaluation. The advantage of mockups lies in the fact that they may be seen as digital drawings which allows the developer to rearrange UI components easily. Functionality may be added to the design which enables its testing.

It is intended that the language of the application shall be adjusted automatically to the smartphone’s language settings as was implemented in the existent application “Defi Now!”. After the user opens the application and does not have the location services activated on their smartphone, they are shown a dialogue box prompting them to activate them (Figure 81), according to the standard procedure of applications that require the activation of location services. If the user declines, they are not able to use the app to its full extent and do not the specific address of the nearest AED locations, as is a custom practice within applications requiring the activation of location services (e.g. “Google Maps”). Otherwise the user may also quit the application by pressing the designated button “Quit” (Figure 82). If the user has already enabled the location services on their smartphone previously, this dialogue is not required.

[6] http://www.balsamiq.com/products/mockups

Figure 81 "Defi Now!" Starting Screen

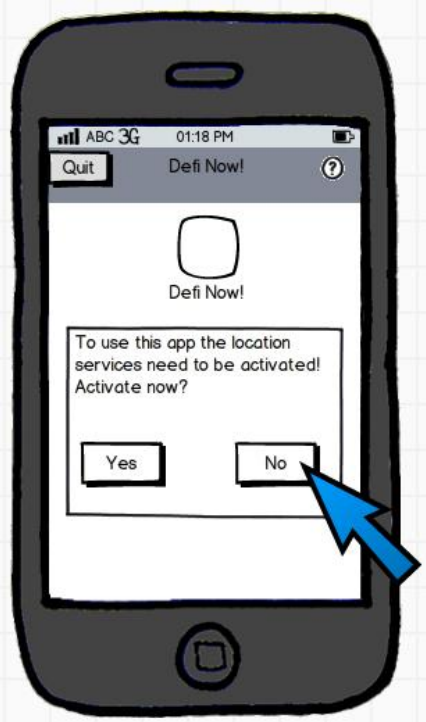


Figure 82 If the User Chooses "No" They May Choose “Quit” to Exit the App or May Use The App with Restraints

If the user selects "Yes" they are redirected to a screen asking them to either select the “Emergency Mode” or “Explore Mode” (Figure 83). This feature is proposed to users to offer them different features. For example when selecting the “Emergency Mode” the user is able to place an emergency call, a function that is not available in the “Explore Mode”. The latter is supposed to give the user the possibility to explore the application without fearing to place an emergency call by accident, but to get acquainted with the app without the hecticness during an emergency. Moreover in this mode they are allowed to add a new AED location if they have spotted one that is not yet listed. If witnessing an emergency, no user will add a new AED. Recognizing such a function might only distract the user and precious time might be wasted trying to find appropriate features. Therefore this function is outsourced from the “Emergency Mode” and placed within the “Explore Mode”. This allocation might promote an overview to the user, whereas specific functions that are not needed in an emergency, such as adding a new AED, are not embedded in the mode utilized in an emergency situation.
The application may be quit via the quit-button at the left-sided top of the screen (Figure 84 left image). Further, from every position the user is in they are able to return to the top-level screen for mode-selection via an exit-button, which is always located in the same position to guarantee conformity with the user’s expectations (Figure 84 right image).

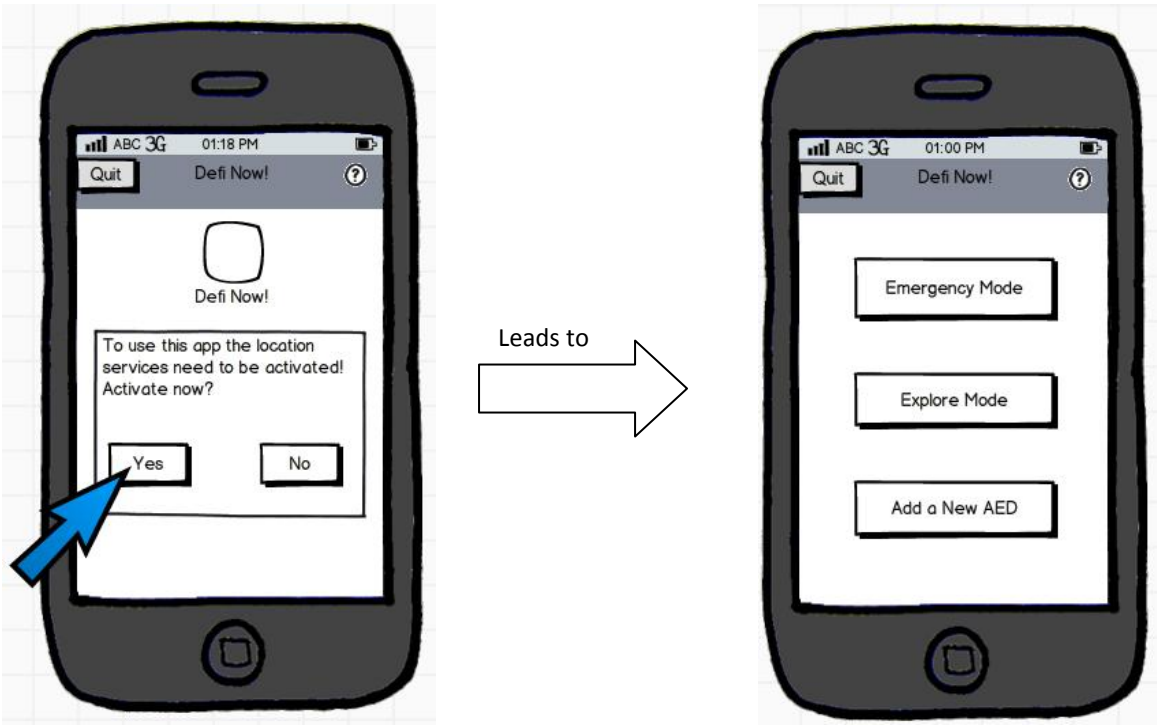


Figure 83 The User Can Choose Between “Explore Mode”, “Emergency Mode” or “Add A New AED”

As soon as the user selects the “Emergency Mode” they are inquired whether or not they want to place an emergency phone call (Figure 84). For reassurance and to avoid emergency calls by mistake, the user has to affirm wanting to dial the emergency number (Figure 85-Figure 86a). As implemented in the “Defi Now!” app, introduced and evaluated in section 9, the emergency number shall be automatically adjusted to the user’s whereabouts. Nevertheless this feature is only available to the user if they have activated the location services. Otherwise the exact address may not be assigned and will be allocated freely.

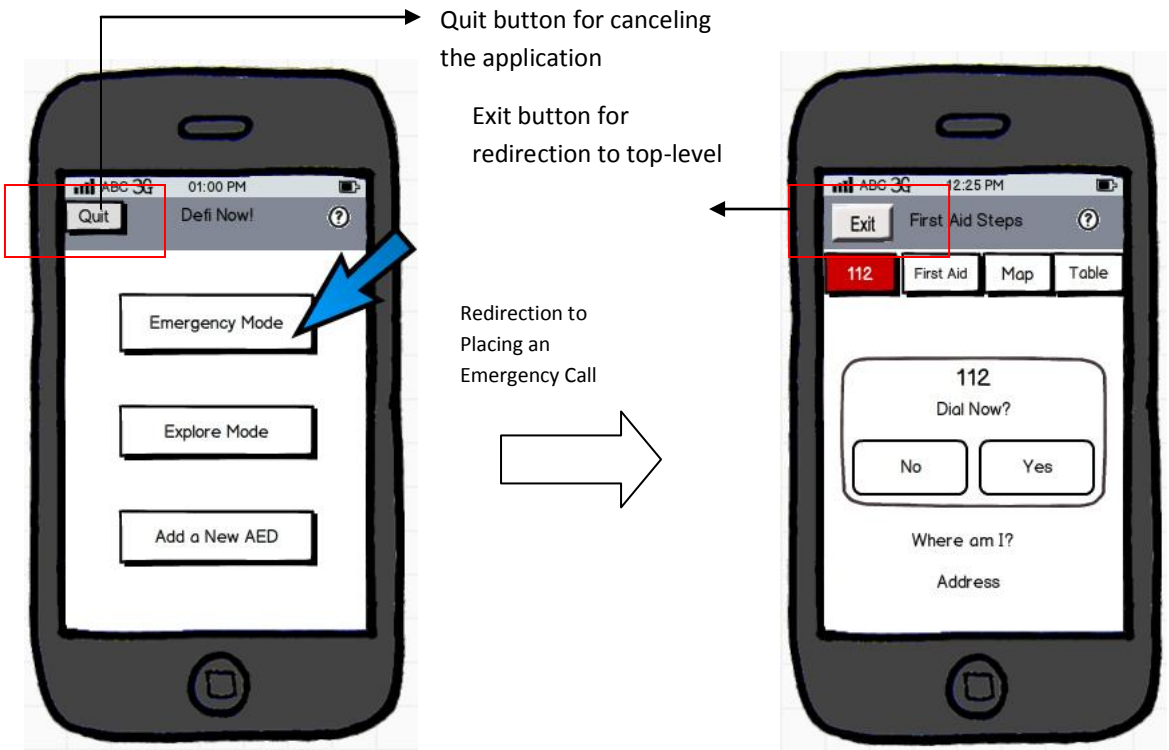


Figure 84 Selecting Emergency Mode Redirects to Emergency Call

If the user does not want to place an emergency call they are able to use the application anyway by tapping on the other tabs “First Aid”, “Map” and/or “Table”. They are also able to return to the tab “112” any time and place an emergency call if they desire to do so.

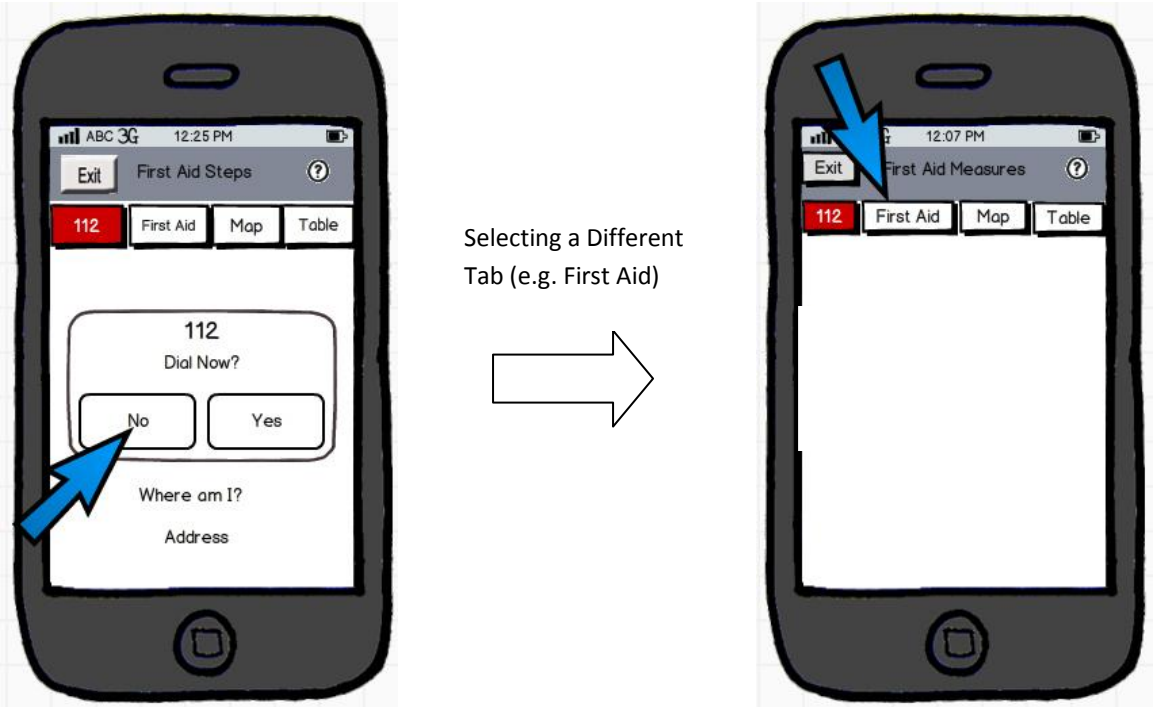


Figure 85 If The User Does Not Want to Dial the Emergency Number they May Select Different Tab

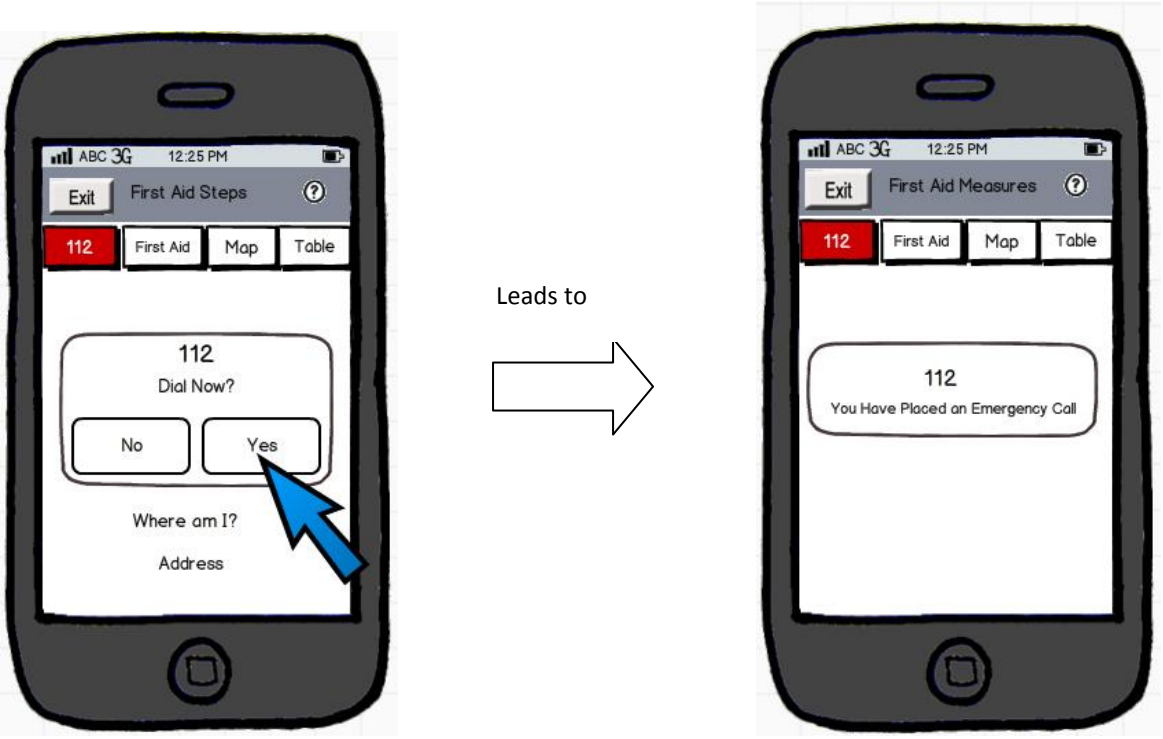


Figure 86 a) User Dials the Emergency Number b) Confirmation of Having Placed an Emergency Call

If the user placed an emergency call, an information box appears confirming the user's action. This feature, offering informative feedback, is supposed to give reassurance to the user in case they have forgotten whether or not they have dialed for help (Figure 86b). Sensible thoughts are not always possible when witnessing an emergency and a reassuring dialogue might be helpful.
Further, receiving a message stating that the emergency call has already been placed assures that a user cannot dial the emergency number twice in a row. If the user quits the application entirely and restarts it, calling the emergency number is possible again.

Independent of placing an emergency call, the user is able to navigate through the app via the buttons at the top of the screen. From every position they are in, they can simply reach a desired feature without having to sequentially navigate through the app and click back-buttons for redirection (Figure 87). This navigation form might lead to time saving because additional clicks can be prevented. Thus the clearness of the app is emphasized because the user does not have to memorize hierarchies, which he has to when using the current version of the app "Defi Now!"(Status Dec. 2012). The user also might notice a learning effect and memorizes that all of the app's possible functions are located at the top of the screen and does not waste time searching for them. The section, which is currently utilized by the user, is distinguished by a red color, supplying visual guidance as well.

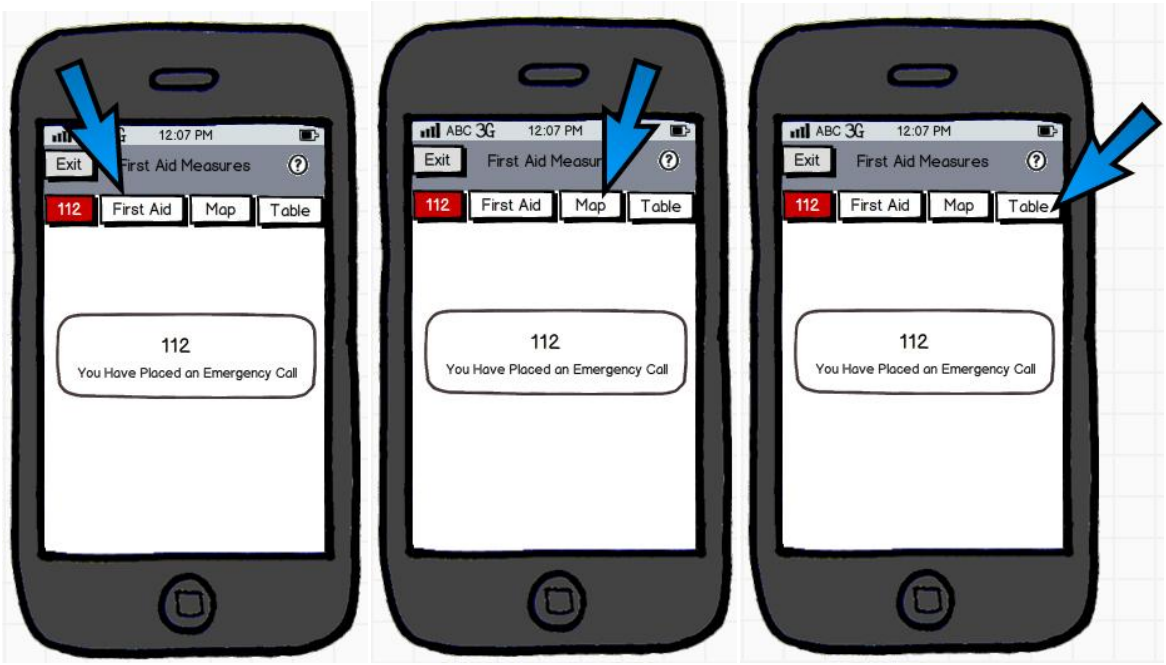


Figure 87 Options for Next Steps of Navigation through the App

As well as in the current version of “Defi Now!” the user is displayed a guideline for administering first aid as soon as they select this feature (Figure 88). Due to results obtained during the evaluation of the usability study, the guideline was adjusted with focus on enhancing the clarity. Therefore more graphical support is given to the user. A resuscitation beat may be selected by simply pressing the grey highlighted button labeled “With Breathing” or “Without Breathing” directly embedded in the CPR guideline, as many testees expected. If the user refrains from mouth-to-mouth respiration and selects “without breathing” the resuscitation beat is adjusted to 100 beats per minute, predetermined by a metronome, which acoustically encourages the first responder to administer CPR with the correct rhythm. The chosen resuscitation beat is emphasized by a light gray box offering more structure to the image. Since the study participants mostly did not recognize the circular symbol referring to a repetition of chest compressions with or without mouth-to-mouth-ventilation (mouth-to-nose-ventilation) it is now depicted more clearly with labeling as well as more eye-catching in a red color.

As soon as the user taps on the integrated blue speaker symbol the metronome sounds, presetting the selected resuscitation beat. If a metronome is active the speaker symbol is graphically different from an inactive speaker, respectively metronome. By tapping on the speaker symbol again the metronome is stopped. This feature seems to be more conformal to user expectations since they are familiar with enabling or muting the speakers on their computer the same way by tapping on the speaker symbol in the taskbar. During the evaluation of the existing app “Defi Now!” several users pointed out that the labeling of the button referring to stopping the resuscitation beat needed optimization. By integrating the feature of starting/stopping the resuscitation beat into the CPR guidelines and reverting to the familiar practices, this feature is optimized to the user’s expectations. Moreover, by integrating the feature of choosing a resuscitation beat in the guideline itself, no buttons need to be added to the bottom of the screen (see Figure 57) , resulting in an economy of space, which may be used for displaying a larger part of the CPR guidelines graphic.

The resuscitation beat is set to a rhythm of 30:2 by default because independent from previously described research results by Dr. Ken Nagao et. al, CPR with artificial respiration is the current method for performing CPR. Given the fact that many first responders react hesitant by the thought of having to perform mouth-to-mouth ventilation to a perfect stranger, and as a result might not administer first aid, offering the possibility to change the settings regarding the resuscitation beat to cardiac-only is an important addition to the general beat of 30:2. By enabling the user to change the settings they obtain an extent of individualization. (Ken Nagao et. al, 2007)

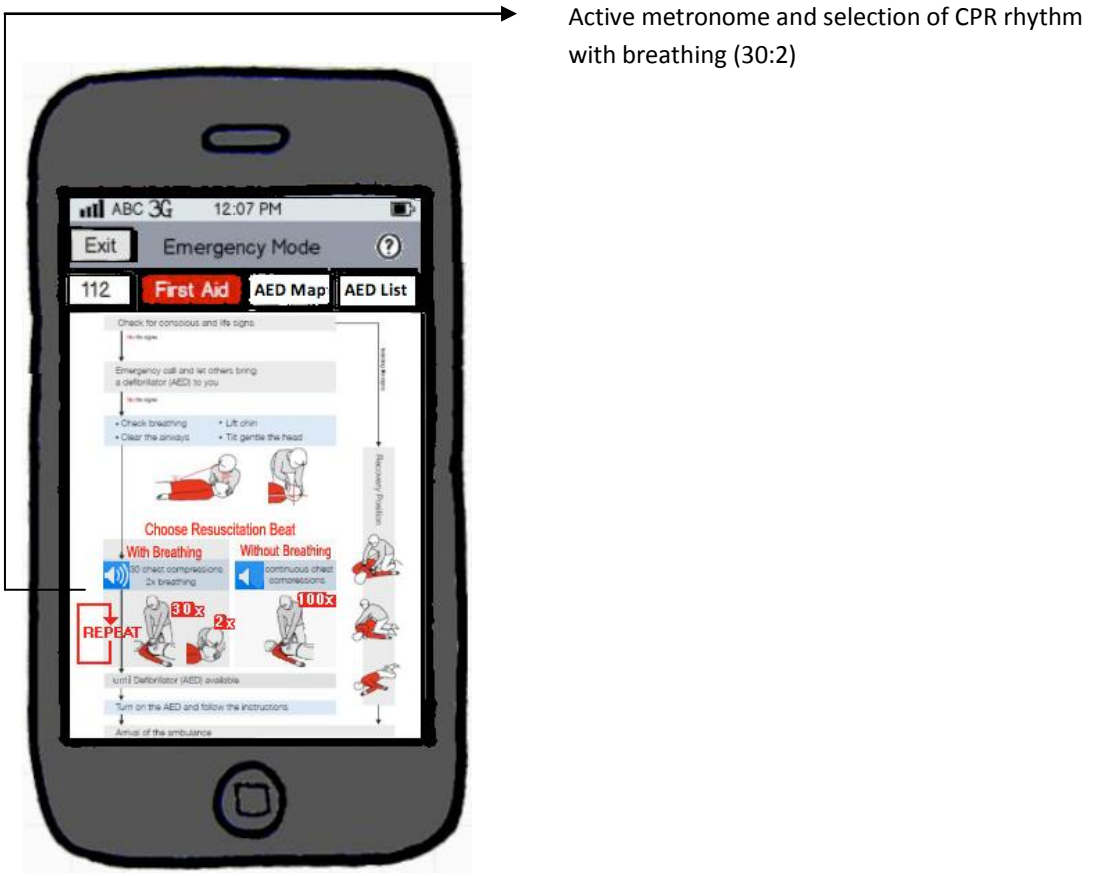


Figure 88 Guidelines for Administering First Aid

When clicking the map-button the user gains a spatial overview of the stored AED locations (Figure 89a). Zooming per gesture control enables the user to sight even more AEDs, as can be seen in Figure 89b. The evaluation of "Defi Now!" yielded results referring to the utilization and conformity of user expectations of hypertext. To provide familiar usability this feature is embedded in this mock-up. Therefore the user is able to view additional information regarding a selected AED by simply clicking on the balloon (Figure 90).

In order to be able to improve the existing app "Defi Now!" it might be considered to offer an offline search. As implemented in the app "AED Laocator (DE)" (Section 5.5) the user might have the possibility to store the complete database or perhaps a partial one, depending on their GPS-location and a preset radius, on their smartphone. Thereby the user would be allowed to obtain information from the database without permanently having to be online. In the end, dependent on the user's position, they only need the five or ten nearest AED locations to be displayed to them. Storing them on the user's smartphone does not require too much storage space and might be implemented as an optional feature, ensuring suitability for individualization to the user's needs.

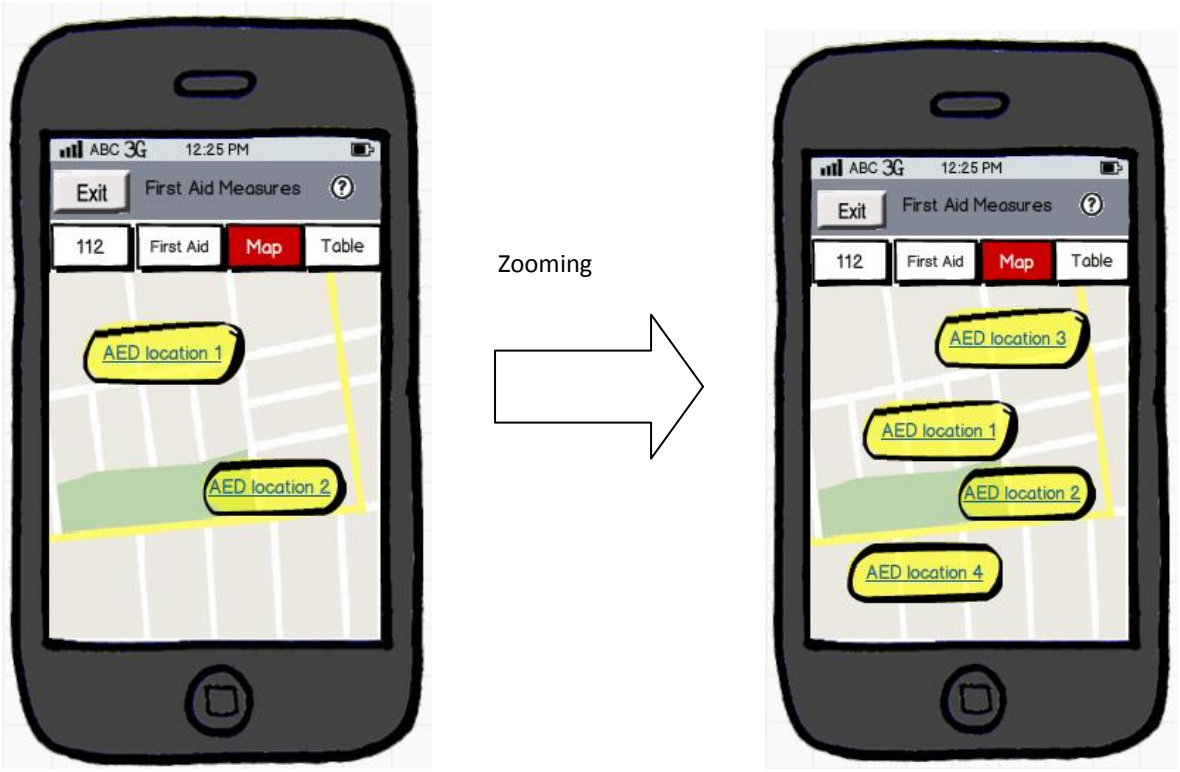


Figure 89 a) Display of the Map and AED Locations b) Zooming Out of the Map Offers More AEDs to the User

Figure 90 Selecting of an AED of Choice

Once the user has opened the additional information, they shall be provided with information concerning the exact address of the AED's location (Figure 91). Moreover opening hours shall be displayed to them, as well as pictures, which shall supply spatial orientation to the user as was already implemented in the current version of "Defi Now!". This feature was approved by the study participants who rated the display of pictures, as visual guidance regarding the spatial orientation, as being very helpful.

Because of the distribution of the users' opinions regarding the closing mechanisms of the information balloon (section 10.7), one obvious closing icon was applied. Because of the high percentage of survey participants, who appreciate the generally known and utilized "X", it hence denotes closing the information associated with a specific AED (Figure 92).

Figure 91 Display of Additional Information

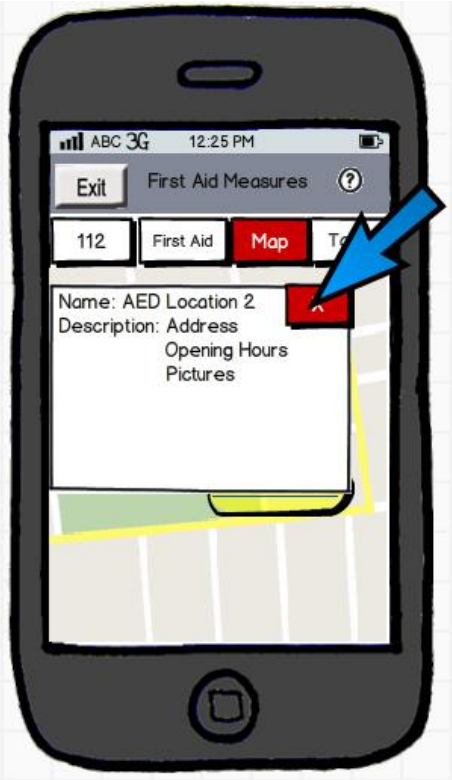


Figure 92 Closing Mechanism

To enhance the clarity of the app, the possibility to switch between the map and a table view displaying the locations of the AEDs is provided. This associates the AED's address with its location in the map and promotes the spatial imagination of users, especially if they are not familiar with the area, as already seen in the app "Defi Graz" (Figure 93).
Hereby, the additional information regarding an AED is displayed to the user as already seen in the map (Figure 90 vs. Figure 93). Contrary to the existent version of "Defi Now!", the utilization of hypertext for redirection was used consistently in the map as well as in the table view.

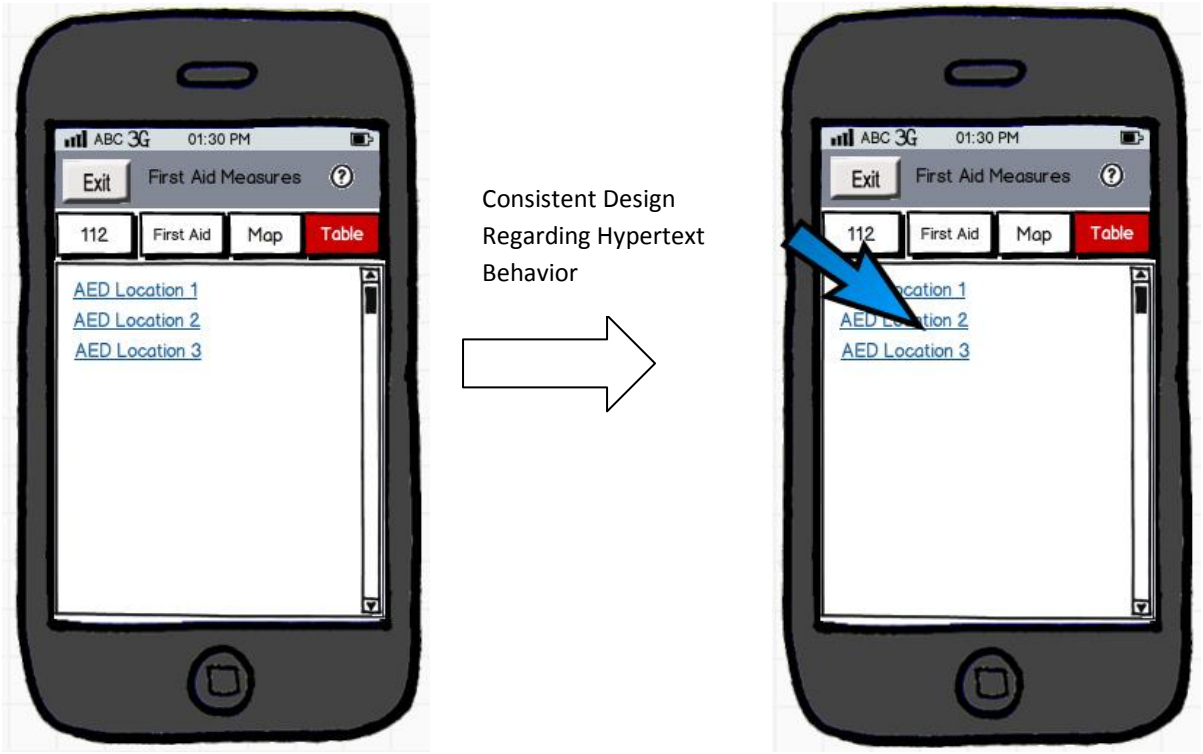


Figure 93 a) Table View b) Selection of AED via Hypertext Behavior

Besides the “Emergency Mode” the user is offered an “Explore Mode”, which allows them to explore the app inoperative, as stated before (Figure 94). The “Explore Mode” supplies basically the same functions as the “Emergency Mode” with the difference that the user may not dial the emergency number.

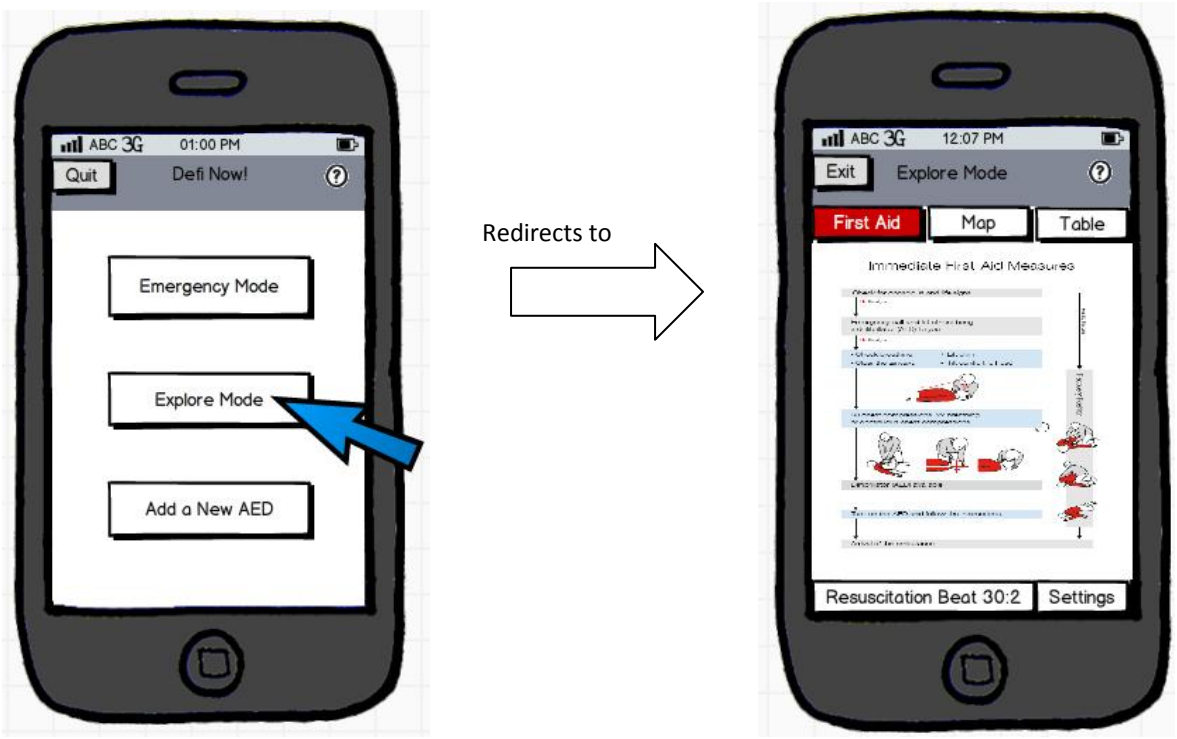


Figure 94 Explore Mode

Further they application users are provided with the possibility to add a new AED location to the database (Figure 95). To enhance the clarity of the app this feature was outsourced as an own menu section, referring to the suggestions proposed by the usability study participants.

When adding a new AED to the database, the user is prompted to distinguish the location's address and describe it more detailed for supplying better orientation. Optional they may upload a picture referring to the AED's exact spatial position. By clicking the button "Save New AED Location" the procedure is finalized (Figure 96). A dialogue field might be added questioning the user if all data is correct and if they really wish to submit the new AED position. This might supply more reassurance to the user. The newly saved AED position should be viewable as soon as it is submitted. (Figure 97- Figure 99)

Figure 95 Adding a New AD Location

Figure 96 Save New AED Location

Figure 97 Map with Inserted New AED

Figure 98 Selecting an AED for Gathering Additional Information and Viewing New AED with Additional Information

Figure 99 Table View of Existing AED Locations

Additionally to a dialogue system questioning the user if they really wish to submit the new AED position, the user should be able to adjust the information they submitted themselves, as is possible with “Defi Now!” (Figure 100). This section might consist of features such as reporting a problem concerning an AED to a central office, as possible in the application “Arrêt Cardiaque 2.0” (see section 7.4). Further the user should be offered the opportunity to modify their registered AED or optionally delete it.

Figure 100 Modify AED

To ensure accessibility even to visual impaired users, the app might profit of a speech-based interface. Instead of only receiving instructions via textual output, the user would be allowed to enable speech, a feature possibly supporting the graphical representation of first aid measures. The advantages of speech-based systems are characterized as follows: visual tasks demand full attention. Dialogues or conversations can be conducted „en passant". Moreover when driving or during poor lighting conditions, speech-based systems have several advantages. (Preissner, 2008) The user does not have to read instructions displayed on their mobile GUI if a speech-based system exists, but is able to receive them acoustically. If they receive instructions via speech, they even do not have to hold the device in their hand. Moreover it can be laid beside them. The user then has the possibility to operate even more freely, a high advantage, when administering first aid at an emergency site. Studies conducted by the Fraunhofer Institute proved a great advantage of speech-driven systems combined with graphical user interfaces. (Preissner, 2008) Offering the user the alternative of enabling or disabling this feature, they would be offered a high amount of individualization. 59.64% would appreciate the possibility of enabling language statements in order to receive assistance in an emergency situation.

12. Conclusion

With the support of “Defi Now!” and its embedded graphics, first responders are encouraged in their actions regarding the administering of first aid. If they feel insecure, they are able to quickly polish up their knowledge in first aid by simply viewing the displayed graphics, or follow the instructions represented to them. A metronome predefines the resuscitation beat and only needs to be followed. Further the rescuer is able to adjust the CPR settings to their liking. Moreover the locations of possibly live-saving AEDs are depicted in a map, which supports spatial understanding, even in a foreign city.

To offer a higher degree of accessibility, perhaps even to users with disabilities, it might be considered to implement the option of language statements supporting the performance of first aid measures. To ensure individualization on the smartphone user’s behalf, this feature should be individually adjustable. The language statements would have to adjust themselves automatically to the smartphones language settings, as the rest of the application already does. Then users would be able to operate freely without having to hold the device in their hands or having to read the instructions regarding first aid. If the application would be able to give acoustic instructions, it should also be able to receive comments by the user. Perhaps if the user does not understand an instruction given by the device due to loud background noises, the possibility should exist that the user inquires the device once more. Therefore simple prompts should be available, e.g. “again” to receive a repetition of the instruction and “forward” to receive the next instruction.

Another supplementary feature might be an offline search option. By storing the complete data regarding AED locations on the smartphone the user would not have to activate the location services. They might simply search for nearby AEDs in a requested city via a table view. Moreover enabling offline search would guarantee access to the AEDs’ data even if no mobile phone network is available.

In order to obtain access to a high number of available AEDs, the publics’ help is needed as well as a coalition of responsible AED database operators. By merging AED data nationally or even internationally, “Defi Now!” might become an application suitable for broad utilization. Nevertheless the public forms the leading part for enhancing the application’s usability regarding the allocation of AED data.
Therefore the attention of the public should be called to this first aid application and its potential as well as helpfulness, leading to a vaster distribution of “Defi Now!”. On that account it might be considered to promote “Defi Now!” via social utility tools to reach a sufficient large number of people additionally to advertisement regarding the app in first aid courses.

Summarizing the results yielded throughout the conducted usability study and adding the two anecdotes from the introduction, it becomes clear that enlightenment of the public regarding sudden cardiac arrest and the utilization of AEDs is essential. Considering the vast distribution of smartphones nowadays, what better platform may be used to reach a vast number of people? Hence the assumption seems natural that propagating a smartphone application as “Defi Now!” and the consequential result of enlightening the users might lead to a broader willingness to help others and a higher survival rate for those experiencing a sudden cardiac arrest.

13. Table of Figures

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I Appendix – The Questionnaire in its Original Language German

Liebe Untersuchungsteilnehmerin, lieber Untersuchungsteilnehmer, um Ihr Einverständnis zur Teilnahme an dieser Studie zu erklären, bitte ich Sie dieses zu lesen. Sie sind eingeladen an einer Studie zur Mensch-Maschine-Interaktion teilzunehmen. Die Studie wird im Rahmen einer Diplomarbeit einer Studentin der Universität in Koblenz im Bereich Softwareergonomie durchgeführt.

Ziel der Studie:
Diese Studie soll die Bedienbarkeit von Smartphone-Apps testen. Im Verlauf der Studie kann es zu emotionalen Stresssituationen kommen.

Anonymität und Vertraulichkeit:
Bitte beachten Sie, das alle Aufzeichnungen und Antworten die während der Sitzung anfallen selbstverständlich streng vertraulich behandelt werden. Darüber hinaus wird Ihre Identität anonym verbleiben und in keiner Weise mit den Forschungsdaten verknüpft. Die Aufzeichnungen werden nicht an Dritte weitergegeben und nur im Rahmen dieser Studie verwendet.

Zustimmung zur Teilnahme:
Mit dem Weitermachen stimme ich folgendem zu:

☐ Ich habe verstanden, dass die Teilnahme an dieser Studie freiwillig ist und ich jederzeit die weitere Teilnahme abbrechen kann.

☐ Ich habe diese Einverständniserklärung gelesen und verstanden. Alle meine Fragen bezüglich der Studie wurden beantwortet und ich bin damit einverstanden an dieser Studie teilzunehmen.

Vielen Dank.

Vorangehende Fragen

Welcher Altersgruppe gehören Sie an?

☐ <18 Jahre ☐ 19-29 Jahre ☐ 30-45 Jahre ☐ 46-60 Jahre ☐ >60 Jahre

Wie fühlen Sie sich zur Zeit?

☐ gut ☐ entspannt ☐ müde

☐ angespannt ☐ nervös ☐ schlecht gelaunt

Haben Sie zur Zeit irgendwelche körperlichen Beschwerden?

☐ Ja ☐ Nein

Wenn ja, welche?

……
……
……

Welches Gefühl hat der eben gezeigte Filmausschnitt bei Ihnen ausgelöst?

☐ Angst ☐ Glück ☐ Trauer ☐ Ekel ☐ Keine Emotion

Bitte lesen Sie folgende Aufgaben durch und antworten Sie möglichst spontan. Treffen folgende Aussagen auf Sie zu? Sie haben fünf Auswahlmöglichkeiten. Kreuzen Sie bitte die für Sie treffendste Aussage an.

Aufgabe 1
Erste-Hilfe-Maßnahmen

Geben Sie aufgrund der unter Menüpunkt 2 aufgeführten Grafik Anweisungen zu Erste-Hilfe-Maßnahmen.

Ich habe zu jeder Zeit verstanden, welchen Schritt ich als nächstes durchführen muss.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich hätte mir mehr Anleitung erwünscht.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich war unsicher was die Reihenfolge der Erst-Hilfe-Maßnahmen betrifft.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Die Grafik hat mir geholfen die nächsten Schritte zu verstehen.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe das Symbol an der Grafik gesehen, welches eine wiederholte Durchführung der Herzrhythmusmassage andeutet.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich hätte mir die Möglichkeit gewünscht eine Sprachanweisung zur Unterstützung der grafischen Darstellung aktivieren zu können.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Die Grafik hat mir nicht geholfen die nächsten Schritte zu verstehen.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Möchten Sie zu dieser Funktion „Erste-Hilfe-Maßnahmen“ Kritik oder Anregungen äußern?

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Aufgabe 2

Hilfestellung zur Rhythmusfindung bei der Herzrhythmusmassage.

Starten Sie das akustische Signal zur Unterstützung der Erste-Hilfe-Maßnahmen und dann stoppen Sie es wieder. Nehmen Sie dann Änderungen vor, indem Sie sich den Rhythmus einmal mit und einmal ohne Atmung vorgeben lassen.

Ich habe den Auslöser des akustischen Signals leicht erkennen können.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe den Auslöser des akustischen Signals an anderer Stelle vermutet.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich konnte das akustische Signal einfach stoppen.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich würde mir einen deutlicheren Hinweis zum stoppen des akustischen Signals wünschen.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe die Änderungsmöglichkeiten bezüglich der Einstellungen zur Herzrhythmusmassage mit oder ohne Atmung auf Anhieb gefunden.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich finde die Änderungsmöglichkeiten bezüglich der Einstellungen zur Herzrhythmusmassage mit oder ohne Atmung irrelevant.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Möchten Sie zu dieser Funktion „Hilfestellung zur Rhythmusfindung bei der Herzrhythmusmassage“ Kritik oder Anregungen äußern?

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Aufgabe 3
Allgemeine Informationen anzeigen lassen
Lassen Sie sich die allgemeinen Informationen zu dieser App anzeigen und gehen Sie danach auf die Hauptseite zurück.

Ich habe den Informations-Button sofort gefunden.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe den „zurück-Button“ sofort gefunden.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe den „zurück-Button“ oben links erwartet.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe den „zurück-Button“ an anderer Stelle erwartet.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Möchten Sie zu dieser Funktion „Allgemeine Informationen anzeigen lassen“ Kritik oder Anregungen äußern?

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Aufgabe 4
Einen neuen AED-Standort einfügen
Fügen Sie einen neuen AED-Standort in die Karte mit den bestehenden AED-Standorten ein.

Ich konnte einfach einen neuen AED-Standort hinzufügen.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe diese Funktion unter Menüpunkt 3 „Defibrillator finden“ erwartet.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe den Button für die Funktion „neuen AED-Standort hinzufügen“ schnell gefunden.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe die Sprechblase mit dem Hinweis „Helfen Sie mit und registrieren Sie einen neuen AED!“ auf der Hauptseite sofort wahrgenommen.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Möchten Sie zu dieser Funktion „Einen neuen AED-Standort einfügen“ Kritik oder Anregungen äußern?

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Aufgabe 5
Liste mit AED-Standorten anzeigen lassen
Lassen Sie sich eine Liste mit den bestehenden AED-Standorten anzeigen.

Ich habe die Funktion unter dem Menüpunkt „neuen AED hinzufügen“ vermutet.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe den „Listen-Button“ sofort erkannt.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Möchten Sie zu dieser Funktion „Liste mit AED-Standorten anzeigen lassen“ Kritik oder Anregungen äußern?

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Aufgabe 6
Informationen zu den AED-Icons
Lassen Sie sich die Informationen zu den Kategorien der verschiedenen AED-Icons auf der Karte anzeigen und gehen Sie danach wieder zu der Karte zurück.

Ich habe sofort gefunden wodurch ich mir die Kategorien der verschiedenen AED-Icons anzeigen lassen kann.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe mehrfach auf die Icons in der Karte geklickt.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe bei den oberen Buttons nach der Funktion gesucht um mir die Informationen zu den AED-Icons anzeigen zu lassen.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe die unteren beiden Buttons angeklickt um mir die Informationen zu den AED-Icons anzeigen zu lassen.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe die Alternative zum „Schließen-Button“ gewählt um wieder zu der Karte mit den eingezeichneten AED-Standorten zu gelangen.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe den „Schließen-Button“ gewählt um wieder zu der Karte mit den eingezeichneten AED-Standorten zu gelangen.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Möchten Sie zu dieser Funktion „Informationen zu den AED-Icons“ Kritik oder Anregungen äußern?

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Aufgabe 7
Informationen zu einem AED-Standort Ihrer Wahl
Lassen Sie sich die Informationen zu einem AED-Standort Ihrer Wahl anzeigen und schließen Sie diese dann wieder.

Ich habe auf einen AED-Standort geklickt um mir die Informationen wie Adresse anzeigen zu lassen.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe abermals auf den AED-Standort geklickt um die Informationen auszublenden.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe auf die grau unterlegte Sprechblase geklickt um die Informationen wieder auszublenden.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe auf den blauen Pfeil in der grau unterlegten Sprechblase geklickt um die Informationen wieder auszublenden.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Wenn ich nochmals auf einen AED-Standort klicken wollte, um die Informationen wieder auszublenden, ist der dahinterliegende AED-Standort aktiviert worden.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich hätte das weit verbreitete Kreuz-Icon zum Schließen der Informations-Box bevorzugt.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Möchten Sie zu dieser Funktion „Informationen zu einem AED-Standort Ihrer Wahl“ Kritik oder Anregungen äußern?

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Aufgabe 8
Detaillierte Informationen zu AED-Standort anzeigen lassen
Lassen Sie sich nun die detaillierten Informationen zu einem AED-Standort Ihrer Wahl anzeigen.

Ich habe auf die grau unterlegte Sprechblase geklickt um mir weitere Informationen anzeigen zu lassen.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe den kleinen blauen Pfeil angeklickt um mir weitere Informationen zu diesem AED-Standort anzeigen zu lassen.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Möchten Sie zu dieser Funktion „Detaillierte Informationen zu AED-Standort anzeigen lassen“ Kritik oder Anregungen äußern?

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Aufgabe 9

Navigieren durch die App Defi Now! und allgemeines Erscheinungsbild

Navigieren Sie von Menüpunkt 3 (Defibrillator finden) zurück zu Menüpunkt 2 (Erste-Hilfe-Maßnahmen) und beurteilen Sie das allgemeine Erscheinungsbild der Erste-Hilfe-App.

Die Schritte um von Punkt 3 wieder zu Punkt 2 zu kommen empfinde ich als kompliziert.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich empfinde die App Defi Now! als klar strukturiert.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich empfand die Funktionsbeschreibungen als klar verständlich.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich hätte mir eine präzisere Formulierung für die einzelnen Funktionen gewünscht.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich habe leicht durch die Menüpunkte navigieren können.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Ich empfinde die App Defi Now! als verwirrend.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Meiner Empfindung nach ist die App DefiNow! unpraktisch zu bedienen.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Mir gefällt das optische Erscheinungsbild der Version von Defi Now! für das IPhone besser als die Version für das Android-Betriebssystem.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Mir gefällt das optische Erscheinungsbild der Version von Defi Now! für das Android-Betriebssystem besser als die Version für das IPhone.

Trifft nicht zu (1) (2) (3) (4) (5) Trifft zu

Geben Sie einen oder mehrere Gründe dafür an, warum Ihnen ein Erscheinungsbild mehr zusagt als das andere.

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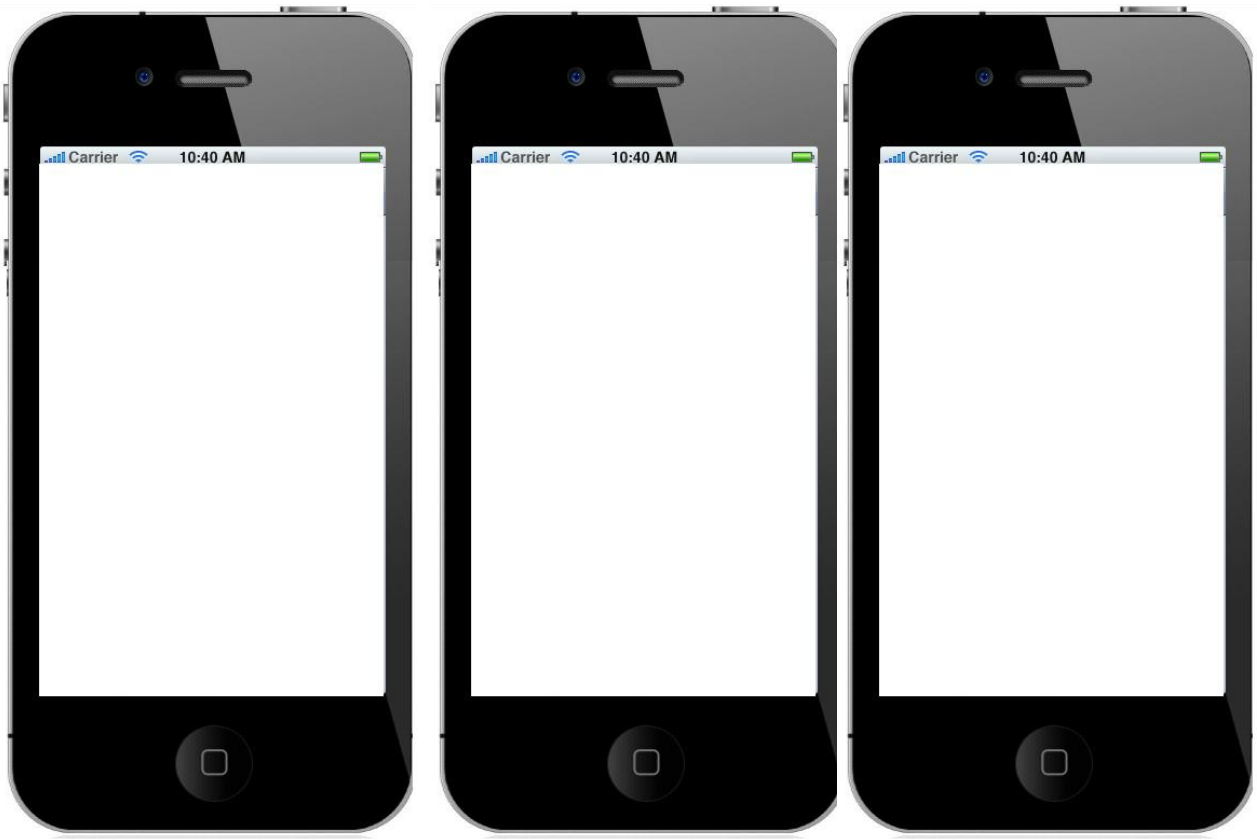
……

Wenn Sie die Möglichkeit hätten ein neues Erscheinungsbild für die App Defi Now! zu erstellen, wie würde dies aussehen? Skizzieren Sie Ihren Vorschlag in die dafür vorgesehenen Smartphonevorgaben (einfache Skizze reicht).



Möchten Sie zu dieser Funktion „Navigieren durch die App Defi Now! und allgemeines Erscheinungsbild“ Kritik oder Anregungen äußern?

……
……
……
……

Abschließende Fragen

Nutzen Sie selbst ein Smartphone?

☐ Ja ☐ Nein

Wie stehen sie allgemein zu Sprachanweisungen?

☐ Störend ☐ hilfreich ☐ egal

Würde Ihnen eine Sprachanweisung bei dieser App hilfreich erscheinen?

☐ Ja ☐ Nein ☐ Weiß nicht

Haben Sie das Gefühl, dass die App Ihnen Sicherheit verleihen würde in einer Notfallsituation richtig zu agieren/handeln?

☐ Ja ☐ Nein ☐ Weiß nicht

Wenn Nein, warum?

.....
.....
.....
.....

Wie lange ist es her, dass Sie einen Erste-Hilfe-Kurs gemacht haben?

☐ noch nie ☐ <3 Jahre ☐ 3-5 Jahre ☐ 5-10 Jahre ☐ >10 Jahre

Würden Sie ein besseres Gefühl haben, wenn Sie wüssten, dass der normale Bürger aufgrund der App in der Lage wäre Ihnen selbst in einer solchen Nofallsituation zu helfen?

☐ Ja ☐ Nein ☐ Weiß nicht

Möchten Sie noch Anmerkungen, Kritik zu der bestehenden App Defi Now! äußern?

……
……
……
……
…….

Vielen Dank für Ihre Teilnahme.

II Appendix – The Questionnaire translated into English

Dear study participants, to give your consent to participate in this study I would like to ask you to read this page carefully. I invite you to participate in a survey regarding human-computer-interaction. The survey is conducted in line of the diploma thesis of a student of the University of Koblenz-Landau in the department of software ergonomics.

Object of this study:
This survey aims at testing the usability of smartphone applications. In the course of this study emotional stress-situations might be experienced.

Anonymity and Confidentiality:
Please note that all recorded answers as well as recordings during the test session will be treated confidentially. Moreover your identity will be kept anonymous and will not be associated with the research data. The recordings will not be forwarded to a third party and are only used in line of this study for evaluation.

Declaration of Consent:
By continuing I agree with the following:

☐ I understand that the participation in this usability study is voluntary and I am able to cancel any further participation.

☐ I have read and understood this declaration of consent. All my questions concerning the usability study have been answered and I agree to participate in this study.

Thank you.

Preceding Questions

Which age group do you belong to?

☐ <18 years ☐ 19-29 years ☐ 30-45 years ☐ 46-60 years ☐ >60 years

How would you describe your current sentiment?

☐ Good ☐ Relaxed ☐ Tired

☐ Anxious ☐ Nervous ☐ Bad Temper

Do you currently experience any discomforts?

☐ Yes ☐ No

If you marked “Yes”, please state which discomforts?

……
……
……

Which emotion did the previously shown film clip induce?

☐ Fear ☐ Happiness ☐ Grief ☐ Disgust ☐ No Emotion

Please read the following assignments and answer as spontaneous as possible. Do the following statements pertain to your opinion? You have five alternatives for answering. Please mark the most appropriate statement.

Assignment 1
First Aid Measures

Please give instructions to first aid measures based on the graphic viewable in section 2 (First Aid Measures).

I have always understood which action I had to perform next.

Not applicable (1) (2) (3) (4) (5) Applicable

I would have hoped for more instructions.

Not applicable (1) (2) (3) (4) (5) Applicable

I was insecure about the order of the first aid measures.

Not applicable (1) (2) (3) (4) (5) Applicable

The displayed graphic helped me to understand the next actions to be performed.

Not applicable (1) (2) (3) (4) (5) Applicable

I recognized the symbol attached to the graphic, which implies the repetitive execution of CPR.

Not applicable (1) (2) (3) (4) (5) Applicable

I would have appreciated an option to enable language statements, which might support the graphical display of the first aid measures.

Not applicable (1) (2) (3) (4) (5) Applicable

The displayed graphic did not help me understand, which actions needed to be performed next.

(1) (2) (3) (4) (5)

Not applicable Applicable

Would you like to add remarks or criticism concerning this function “First Aid Measures“?

……
……
……
……

Assignment 2

Setting the Correct Rhythm to Perform CPR

Please start the acoustic signal as guidance for the first aid measures and then pause it again. Modify the settings referring to a rhythm with mouth-to-mouth ventilation and a rhythm without mouth-to-mouth ventilation.

I easily recognized the trigger for the acoustic signal.

Not applicable 1 2 3 4 5 Applicable

I assumed the trigger for the acoustic signal at a different position.

Not applicable 1 2 3 4 5 Applicable

I could easily pause the acoustic signal.

Not applicable 1 2 3 4 5 Applicable

I would have appreciated a more specific instruction for stopping the acoustic signal.

Not applicable 1 2 3 4 5 Applicable

I immediately detected the facilities for alteration regarding the settings for CPR with or without mouth-to-mouth ventilation.

Not applicable 1 2 3 4 5 Applicable

I think the facilities for alteration regarding the settings for CPR with or without mouth-to-mouth ventilation are irrelevant.

Not applicable 1 2 3 4 5 Applicable

Would you like to add remarks or criticism concerning this function “Setting the Correct Rhythm to Perform CPR“?

……
……
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……

Assignment 3
Displaying General Information

Please have the general information regarding this application indicated to you and then return to the main menu.

I immediately recognized the information button.

Not applicable (1) (2) (3) (4) (5) Applicable

I immediately recognized the back button.

Not applicable (1) (2) (3) (4) (5) Applicable

I anticipated the back button to be located at the upper left side.

Not applicable (1) (2) (3) (4) (5) Applicable

I anticipated the back button to be located at a different position.

Not applicable (1) (2) (3) (4) (5) Applicable

Would you like to add remarks or criticism concerning this function “Displaying General Information“?

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Assignment 4
Adding a New AED-Location
Please add a new AED location into the map with already existing AED locations.
(AED = Automated External Defibrillator)

I could easily add a new AED location.

Not applicable (1) (2) (3) (4) (5) Applicable

I expected this function to be located in section 3 “Find an AED”.

Not applicable (1) (2) (3) (4) (5) Applicable

I easily recognized the button for adding a new AED location.

Not applicable (1) (2) (3) (4) (5) Applicable

I immediately recognized the balloon with the instruction „Assist and report an AED to Defi Now!“

Not applicable (1) (2) (3) (4) (5) Applicable

Would you like to add remarks or criticism concerning this function “Adding a New AED Location”?
……
……
……
……

Assignment 5
Display Table View of Given AED Location
Please have the table view of given AED locations displayed to you.

I assumed this function within section „Adding a New AED“.

Not applicable (1) (2) (3) (4) (5) Applicable

I immediately recognized the button referring to the table view.

Not applicable (1) (2) (3) (4) (5) Applicable

Would you like to add remarks or criticism concerning this function “Display Table View of Given AED Location”?

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Assignment 6
Information Regarding the AED Icons

Please have the information regarding the categories of the different AED icons displayed to you and then return to the map.

I immediately detected how the categories of the different AED icons could be displayed to me.

Not applicable 1 2 3 4 5 Applicable

I repeatedly tapped the icons on the map.

Not applicable 1 2 3 4 5 Applicable

I clicked on the upper two buttons to fulfill the task of displaying the different categories regarding the AED icons.

Not applicable 1 2 3 4 5 Applicable

I clicked on the lower two buttons to fulfill the task of displaying the different categories regarding the AED icons.

Not applicable 1 2 3 4 5 Applicable

I selected the alternative to the close button for returning to the map with the indicated AED locations.

Not applicable 1 2 3 4 5 Applicable

I selected the close button for returning to the map with the indicated AED locations.

Not applicable 1 2 3 4 5 Applicable

Would you like to add remarks or criticism concerning this function “Information Regarding the AED Icons”?

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Assignment 7
Displaying Information of a Specific AED Location
Please have the information of a selected AED location displayed to you and then close the information again.

I clicked on an AED location to receive information such as the address.

Not applicable 1 2 3 4 5 Applicable

I repeatedly clicked on the AED location to hide this information again.

Not applicable 1 2 3 4 5 Applicable

I clicked on the highlighted balloon to hide this information again.

Not applicable 1 2 3 4 5 Applicable

I clicked on the blue arrow within the highlighted balloon to hide this information again.

Not applicable 1 2 3 4 5 Applicable

If I repeatedly clicked on an AED location, to hide this information again, the subjacent AED location was activated.

Not applicable 1 2 3 4 5 Applicable

I would have preferred the generally known and utilized X-Icon for closing the information balloon again.

Not applicable 1 2 3 4 5 Applicable

Would you like to add remarks or criticism concerning this function “Displaying Information of a Specific AED Location”?

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Assignment 8
Displaying Additional Information of a Specific AED Location
Please have the additional and more detailed information of a selected AED location displayed to you.

I tapped on the highlighted balloon to view further information regarding an AED location.

Not applicable (1) (2) (3) (4) (5) Applicable

I tapped on the blue arrow within the highlighted balloon to gain additional information regarding an AED location.

Not applicable (1) (2) (3) (4) (5) Applicable

Would you like to add remarks or criticism concerning this function “Displaying Additional Information Regarding a Specific AED Location”?

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Assignment 9

General Appearance and Navigation

Please navigate from section 3 (Find an AED) to section 2 (First Aid Measures) and evaluate the general appearance of the app "Defi Now!"

Returning to section 2 from section 3 seems complicated to me.

Not applicable 1 2 3 4 5 Applicable

I think the app "Defi Now!" is clearly structured.

Not applicable 1 2 3 4 5 Applicable

I think the function descriptions are easy to comprehend.

Not applicable 1 2 3 4 5 Applicable

I would have appreciated a more precise phrasing regarding the particular functions of this app.

Not applicable 1 2 3 4 5 Applicable

I could easily navigate through the different sections of this app.

Not applicable 1 2 3 4 5 Applicable

The app "Defi Now!" seems confusing to me.

Not applicable 1 2 3 4 5 Applicable

I think the app is impractical to operate.

Not applicable 1 2 3 4 5 Applicable

I prefer the appearance of the iPhone version of „Defi Now!“ compared to the version for Android.

Not applicable (1) (2) (3) (4) (5) Applicable

I prefer the appearance of the Android version of „Defi Now!“ compared to the version for iPhone.

Not applicable (1) (2) (3) (4) (5) Applicable

Please denote one or more reasons for your preference regarding the one or the other „Defi Now!“ version.

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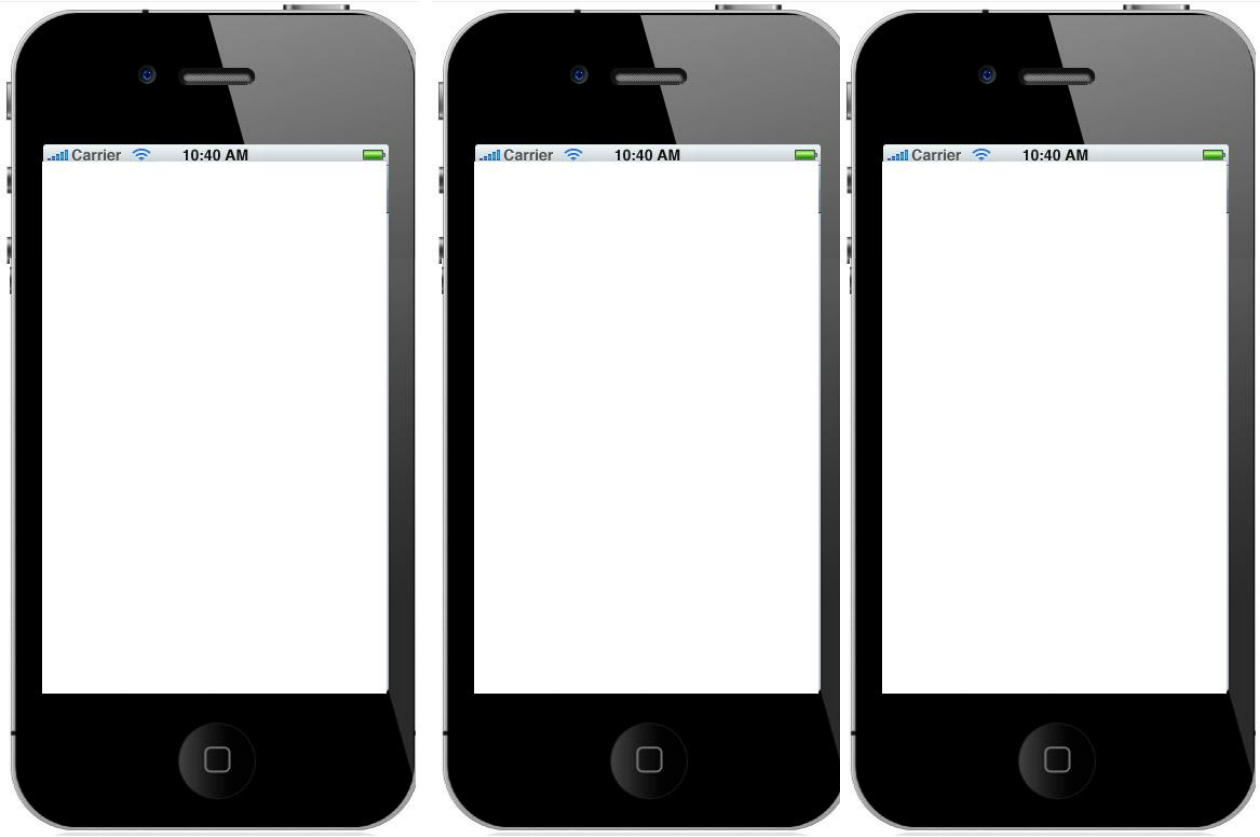
……

If you were given the possibility to adjust the appearance of “Defi Now!“ or to create a complete new one, how would it look like? Please sketch your suggestion within the depiction of the smartphone. A simple draft is sufficient. (optional assignment)



Would you like to add remarks or criticism concerning this function “General Appearance and Navigation”?

……

……

……

……

Conclusive Questions

Do you use a smartphone yourself?

☐ Yes ☐ No

How would you assess language statements in general?

☐ Disturbing ☐ Helpful ☐ Indifferent

Would language statements embedded in this particular app seem helpful to you?

☐ Yes ☐ No ☐ I do not know

Do you think this app would reassure you to act correctly in case of an emergency?

☐ Yes ☐ No ☐ I do not know

If you marked “No“, please state why?

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.....
.....

When did you attend your last first aid course?

☐ never ☐ <3 years ☐ 3-5 years ☐ 5-10 years ☐ >10 years

Would you feel more secure knowing that non-medical personnel could administer first aid correctly in case of an emergency based on this add “Defi Now!“?

☐ Yes ☐ No ☐ I do not know

Would you like to add remarks or criticism concerning the existent application “Defi Now!”?

……
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……

Thank you for your participation.