



QAED

The future of AED training for laypeople.

Appendix of the Master Thesis by Anna Mira Gębala
in collaboration with Laerdal Medical

Master Thesis

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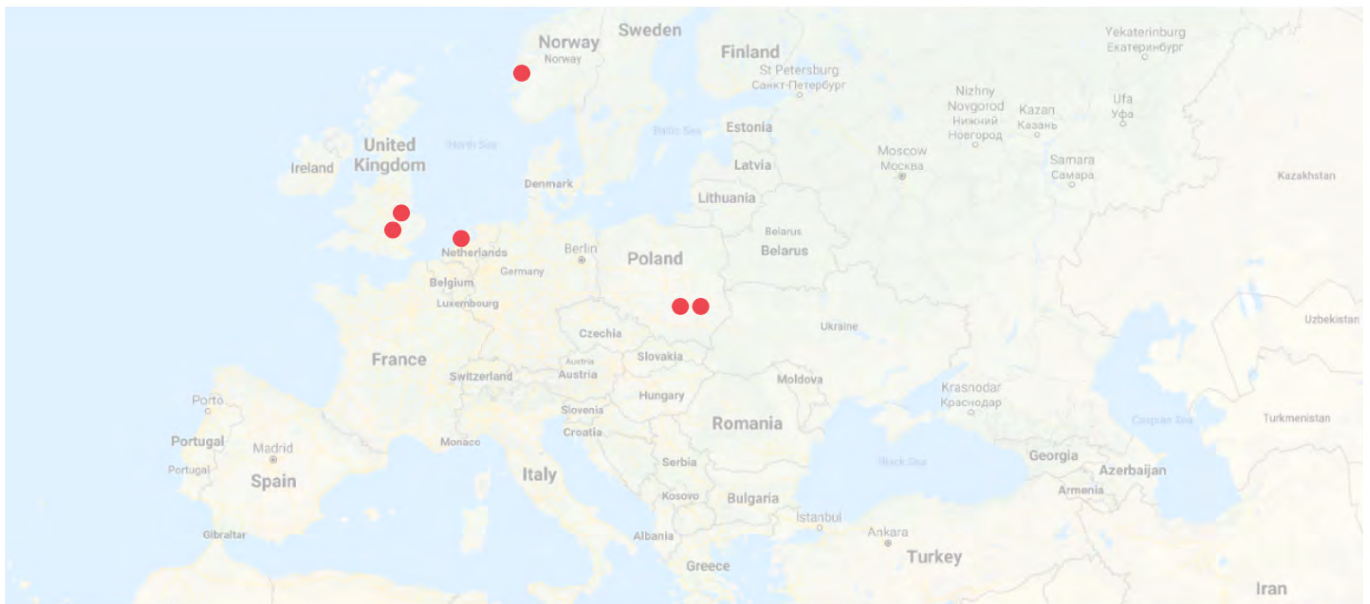
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B. Context & User Research

1. Introduction

As part of the research, multiple methods were used, including interviews, observation and role-playing to gather relevant information from multiple stakeholders and understand different perspectives. Also, research was conducted in multiple locations including Poland, the Netherlands, Norway and the United Kingdom due to the language barriers, travel possibilities and location of company's research partners.

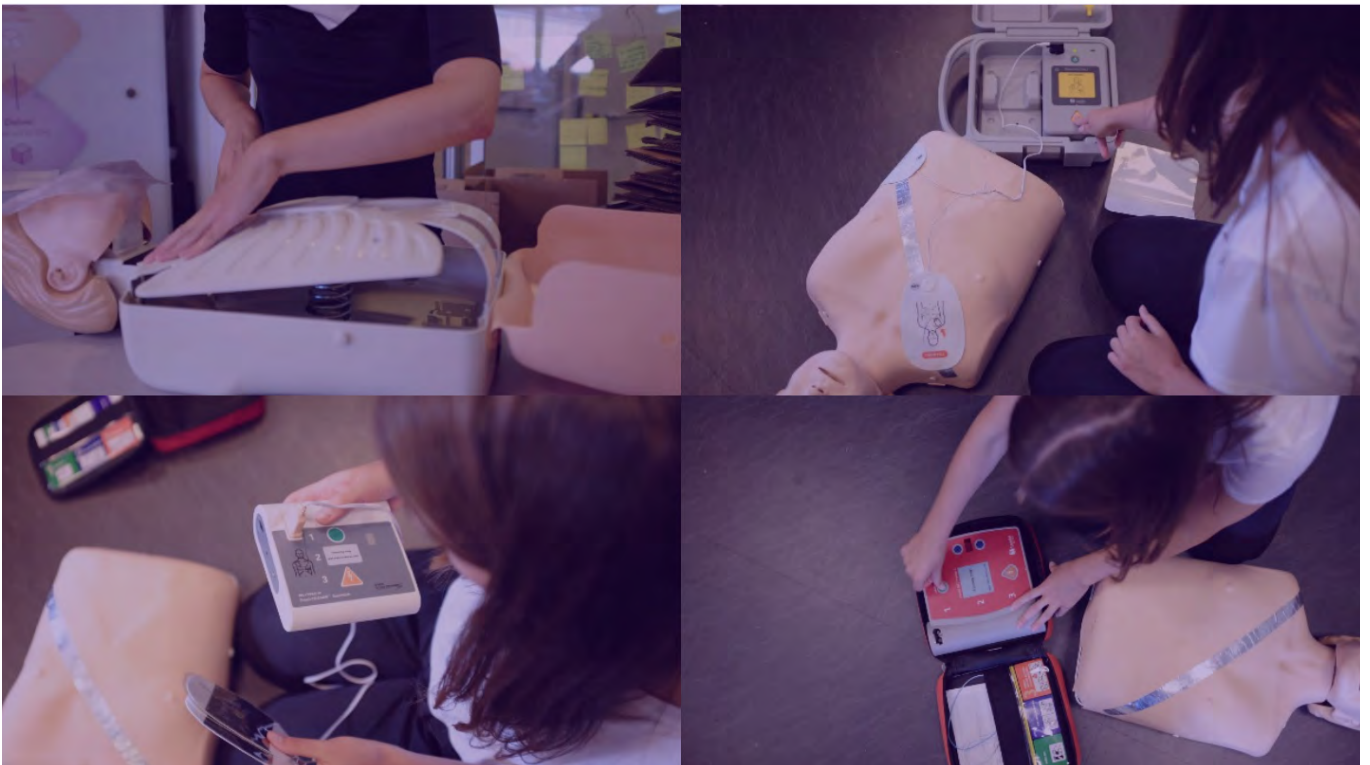




2. Company visit in Stavanger, Norway

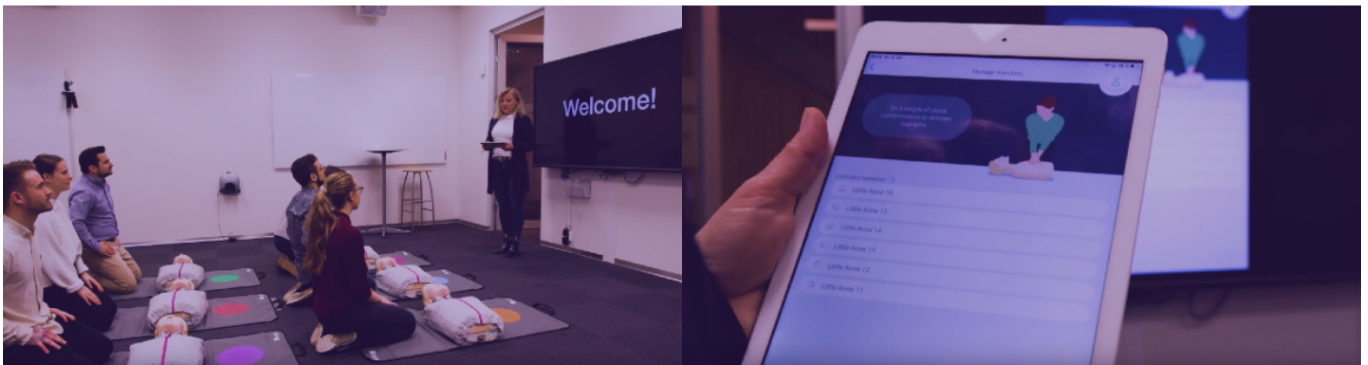
Trip to the Laerdal Medical headquarter in Stavanger was made just before the start of the project. The aim was to define the final assignment and to recognise the client perspective. During those three days, the company had presented their current work, manufacturing facility and their future vision of first aid training. Besides, the testing of their products, including AED trainers and mannequins, was done.

Products testing



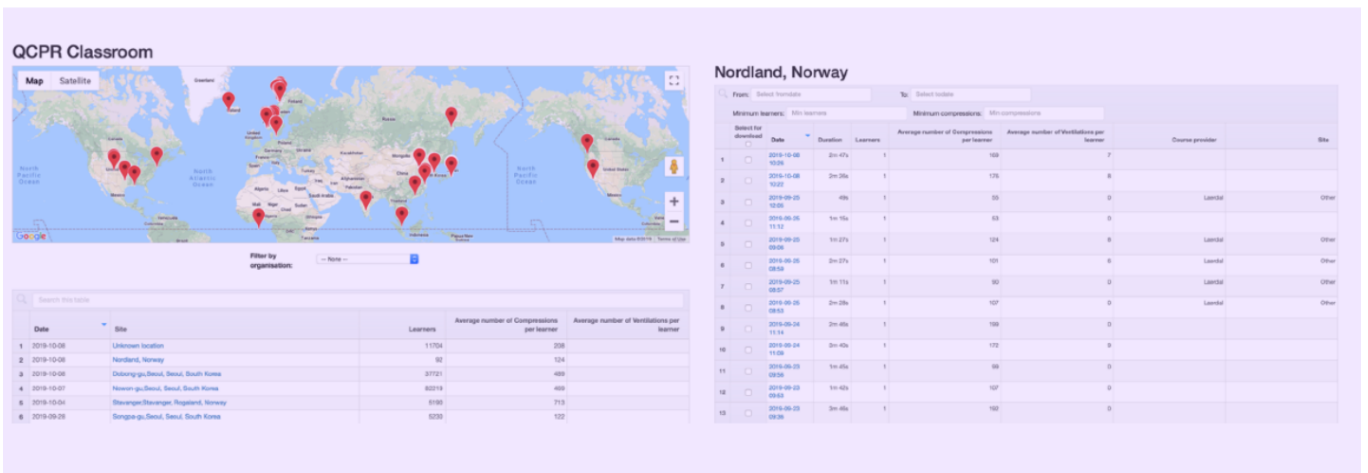
Little Anne mannequin and multiple training AED units were tested. AED training equipment included Trainer 2 and Trainer 3 produced by Laerdal in partnership with Philips but also devices from competitors. Notes from testing were used as the additional content to the functional analyses of AED training devices.

Laerdal's CPRMass B2B future vision



It is a concept of the system which includes Laerdal's QCPR products. It aims to increase the number of instructors who can provide CPR training and make it more accessible. Quality of that training will not entirely depend on the instructor skills and knowledge but on the tools which measure the participants' performance and provide feedback. Also, it will make the training quick with an engaging and memorable experience.

Laerdal's QCPR Classroom data



QCPR Classroom is an open-access platform created by Laerdal. It uses data collected from QCPR mannequins in multiple training institutions and provides an overview of participants performance. Currently, it is not used for research or product development, but its' potential is recognised and further investigated. Laerdal also aims to implement AED in community CPR training, including data collection.

3. Participation in First Aid Training

In order to understand the context of AED training, the role-playing method was used by participating in two certificated first aid courses. The first course was Basic Life Support with additional AED training and the second course was Basic First Aid for Adults. They were provided in different locations by different providers, but they were both aligned with European Resuscitation Guidelines. Also, there were differences in the curriculum, but both of them included AED training and provided insights for the research topic.

Basic Life Support course with AED



Training institution: ERHA plus

Location: Kraków, Poland

Duration: 8 h

Instructor: 1

Participants: 9 and 3

The number of participants had changed during a course as it consisted of 3 separate parts. The initial number of participants during BLS theory and CPR practice was 9, but during AED course there was only 3 participants.



Equipment:

4 mannequins, but only 3 were used (one peer 3 people)

1 AED with a broken speaker



Training methods:

Theory: presentation, lectures, videos, discussion

CPR: practice in a group of 3

AED: videos, demonstration

Key observations:**Deficient AED training despite AED training unit**

Although there was one AED training device, it was not used due to the broken speaker. Device malfunction cause disturbed sound, and it was impossible to practice the skill of following AED voice prompts. However, the device could be used to teach scenario ("fetch AED"), pad placement, a combination of CPR and AED, teamwork and communication which was not used. Personal willingness to use AED was created based on the theory, but the significant lack of confidence was present due to the lack of practice.

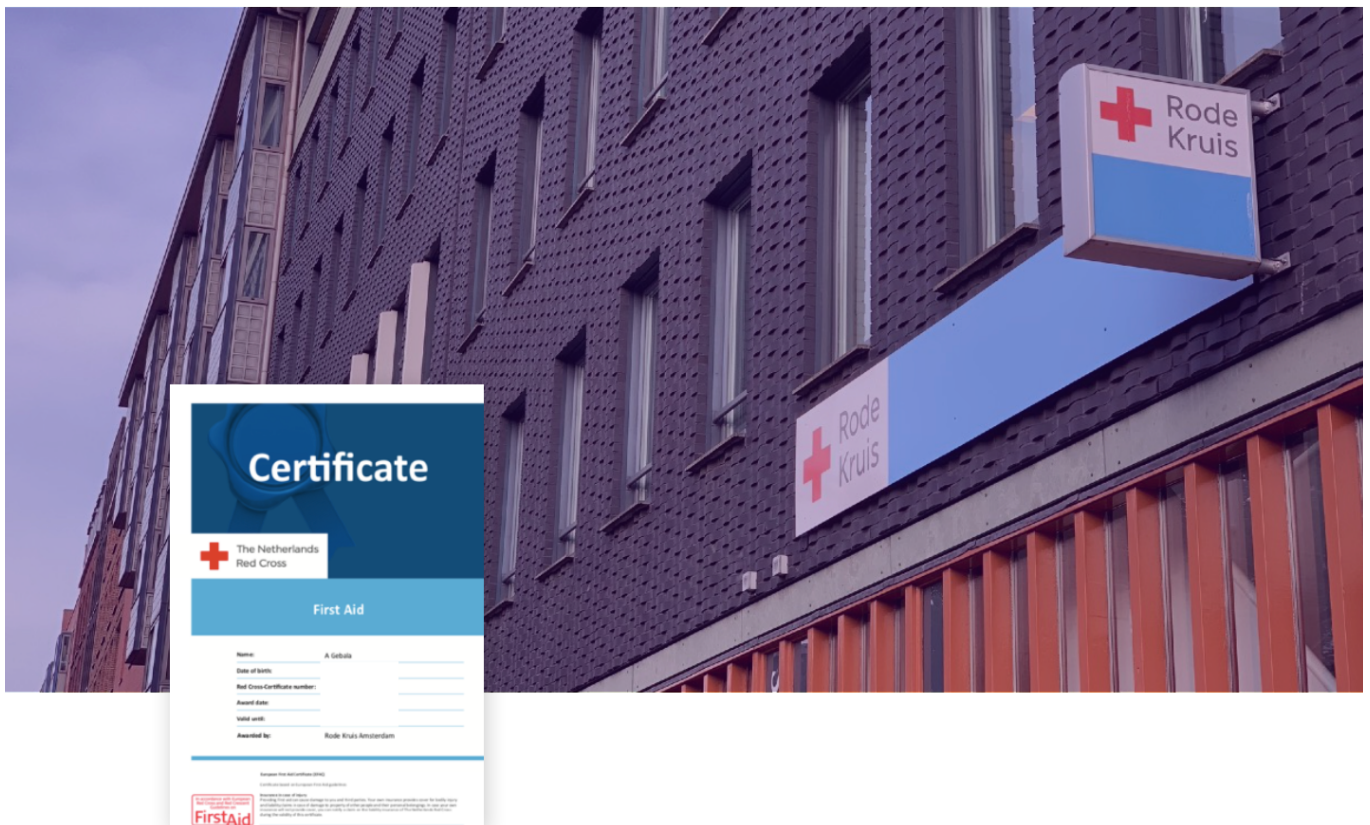
Causes of cognitive overload

An intensive program of the course and short duration caused cognitive overload. A great proportion of theory with facts and figures and not enough breaks resulted in tiredness and low recall of presented material. Besides, the dominant use of verbal presentation and lack of visual elements caused confusion and multiple questions to repeat already given material.

Negative atmosphere

Despite jokes and informal language, the atmosphere of the course could be described as tense and unfriendly. Willingness to perform first aid was build on the necessity due to the law and stress - descriptions of emergency which could include a family member. There was a strong focus on running through the material and completing all parts of the course with a small emphasis on participants. Also, there was no approbation of correct performance and feedback was neutral or negative. Moreover, the negative experience can result in a decrease of willingness to participate in that course again, and it can reflect on the general opinion about first aid courses.

Basic First Aid for Adults



Training institution: Rode Kruis, Team EHBO
Location: Amsterdam, the Netherlands
Duration: 12h (2 days), 2 coffee breaks and 1 lunch break
Instructor: 1,5 (theory 1, practice 2)
Participants: 12



Equipment:
4 mannequins
4 AEDs
4 phones mockups

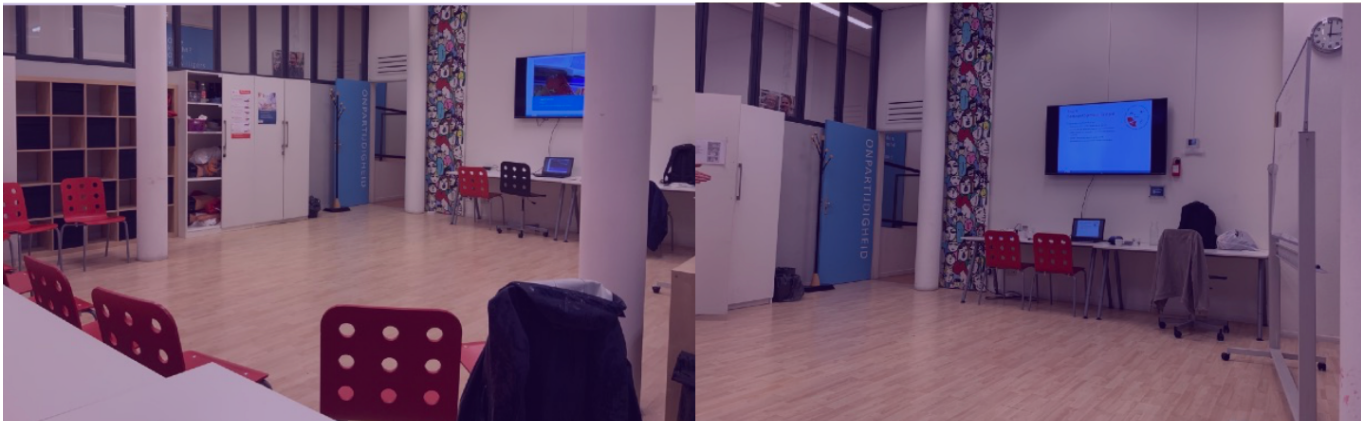


Training methods:

Theory: presentation, lectures, videos, discussion

CPR: practice in a group of 3

AED: discussion, videos, demonstration, practice in a group of 3 in the full scenario of first aid



Key observations:

Willingness & confidence

Willingness to provide first aid was created based on the lectures and presentations. Fact and examples were used to support it. Confidence was gain with a practice of skills separate and in more complex scenarios. They were concerns about unintentional hurting the victim or making a mistake. The instructor stressed it with a direct and strong sentence to convince participants that any action is better than nothing: "if they are not breathing they are already dead - so you can only do better".

Benefits of friendly atmosphere

Breaks and group work enables participants to socialise and create a bond between each other. It resulted in providing peer feedback and supporting each other in a friendly atmosphere.

Questions spark curiosity

At the end of the first training, instructed asked to look for AEDs in participants surroundings and try to pay attention to them. At the second training, the instructor asked multiple questions about AED located in participants home, work and school environment. It raised the lively discussion about devices, the availability and location. Participants reflected on the time it could take them to bring and use it. The excitement was visible between participants about being able to use AED.

Negative feedback and participants engagement

Too detailed feedback and a strong focus on ideal performance during exercising can be challenging for participants and their mood. Also, direct and insensitive way of providing negative feedback can affect participants engagement at the course. Few incidents were observed when instructors feedback resulted in visible signs of participants being upset and retreat from a discussion. Moreover, one event occurred when the participant decided not to perform an exercise due to the disagreement with the instructor. The safe and friendly environment encourages the willingness to perform the exercise and participate in discussions and is an important element of the course.

Summary

- Training institutions use AED differently based on the number of devices: practice but also only for demonstration.
- Courses have different length, but they should provide the same learning outcome. It results is the decrease of practice time or cognitive overload - AED training should allow scaling it according to the course duration.
- Without additional elements which address course atmosphere, it could be stressful and unpleasant for participants.
- Intensive practice in multiple scenarios helps gain confidence.
- Encouraging participants to interact with each other will benefit from peer feedback and a friendly and supportive atmosphere.
- It is important to address negative feedback based on the participants' sensitivity and mixed it with the positive one to maintain their engagement.

4. St John Ambulance training facilities in London, UK

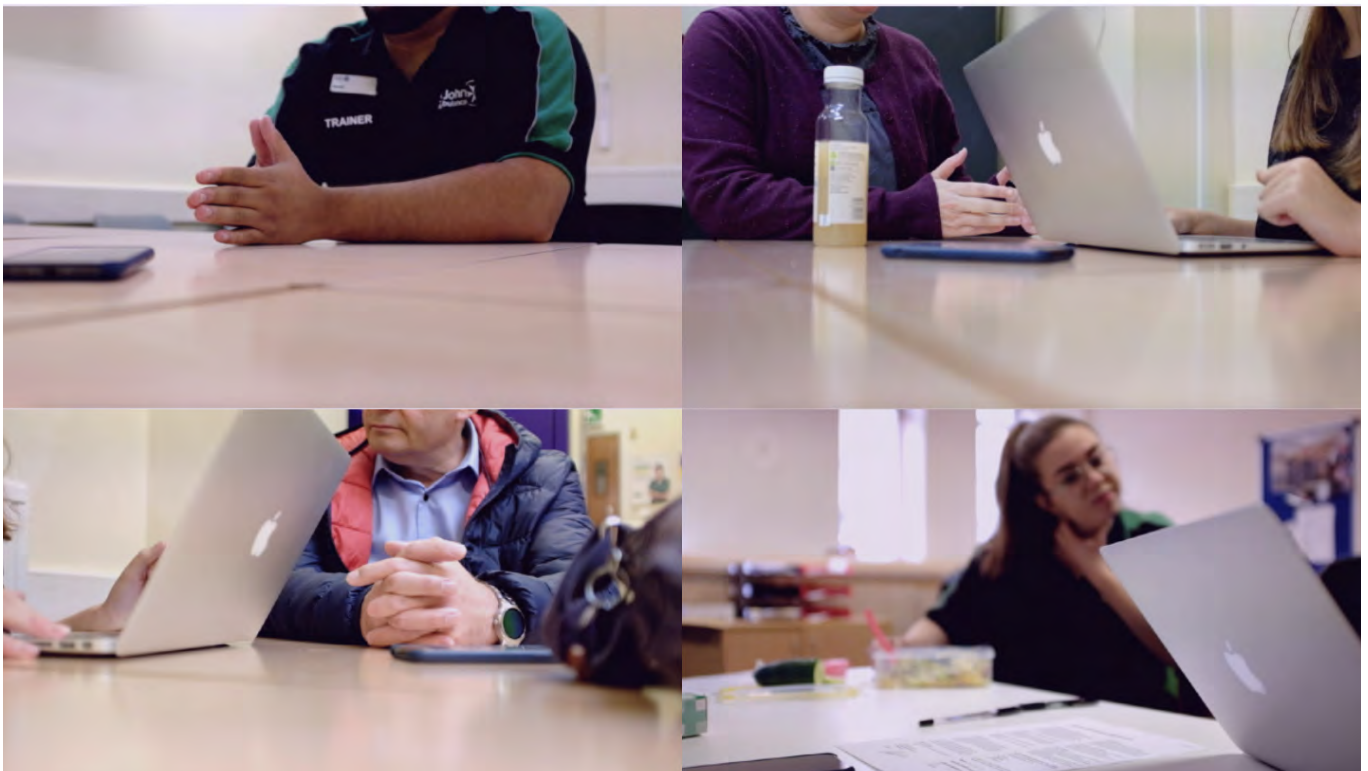


Interviews with St John Ambulance instructors

During two days of the visit, five semistructured interviews were conducted with certified instructors from St John Ambulance. Participants were selected based on the availability and willingness to participate in the study and experience in providing diverse courses which include AED training. Interview questions (Appendix X) were prepared based on the the main research questions.

The main research questions were:

- 1. What is the essential knowledge to demonstrate proficiency in AED use?*
- 2. What teaching methods are used?*
- 3. How AED devices are used during a training by instructors?*
- 4. What properties has desired AED device from instructor point of view?*



Course set up

1. First aid training
24 participants, 2 instructors, 12 mannequins, no AED devices
Paper stickers - no proper training pads
Voice prompts are included in the presentation
2. AED training
6-8 people, 1 instructor, 3-4 mannequins and AED devices
It is ideal when people work in a group of 3

Importance of AED training

- **Gives confidence** ("AEDs are so easy, it is just confidence to make a difference" [REDACTED] "It is serious situation, so the more confidence they have the better they perform" [REDACTED])
- Helps to act effectively and increases the chances of victim survival.
- Empowers to act
- Learn CPR ("AED doesn't do everything" [REDACTED])
- It changes people's perspective.
- They get competence to follow voice prompts.
- Get rid of fears "We see the amount of people who are terrified and clueless. During a training I will get rid of their fears" [REDACTED]
- Better understanding and safety features

Teaching methods

Use variety of methods because different people learn differently.
Adjust the training to the group. "If I have people who did it before I make it more challenging."

General methods:

- **practical**
- questioning
- answering
- reading
- presentation
- work sheets
- visual & audio
- teamwork (learn from each other)

Personal methods:

1. Ask participants to play a scenario in which they provide first aid and use AED at the beginning of the course and use it for comparison in the end of the course.
2. Use remote to give feedback about pad placement and compressions
3. Ask participants to use own hands and body to show pad placements during first aid course.
4. Finish the course with more complex scenarios. Different settings of AED: no shock advise, low battery.

5. Trick participants with touching the mannequin when there is a comment to "stay clear". See if they will notice and react.
6. Add more things to make them think. For example, planters on the mannequin to check if the victim has an implant.
7. Comparisons "I relate AED as setting up a mobile phone, it is easy, you follow instructions, they can relate to it easily" Sara
8. Defibrillation dance "I can easily correct them when they dance and then there are no mistakes when they practice" Sara

Key part of AED training

- **Practice** "The confidence comes from practice" [REDACTED]
- Time awareness "Awareness how much time you have to make a difference." [REDACTED]
- Scenarios "The beauty about scenario is that they learn from mistakes. It is not about perfection." [REDACTED]

Key skills

- **Pad placement**
- **Combination of AED and CPR and minimise delays in CPR**
- Primary survey
- Use of the AED device
- Teamwork
- Stand clear

Addressing emotional needs

- No techniques for addressing emotions in the training
- Talk them through. For example, tell them that AED may not work and it will be not their fault.
- Conversation "Listen what are their fears and get rid of them during a training" [REDACTED]
- Practice helps with emotions.
- Repetition and difficult scenarios "Train hard fight easy." [REDACTED]

Assessment

- Feedback sheet from St John Ambulance
- Encourage peer assessment - it is quite effective
- Observation of participants "it is more time consuming with bigger groups" [REDACTED]
- Own assessment "They do their own assessment by practicing and reflecting. What I hear I forget, what I see I remember, what I do I understand - it is about repetition." [REDACTED]
- QCPR "I don't have to watch everyone at every second and they receive feedback." [REDACTED]

Feedback

"Mistake in the opportunity" Darryl

- Provided during exercising
- Question participant: "What are you doing? Is it effective? What do you think is a problem?"
- Positive encouragement
- Combination of positive feedback and negative when it is necessary

Course atmosphere

- Make people enjoy the course
- Say jokes
- Keep it fun
- Start positive

Participants' struggles during a course

- **They don't struggle as long as they are trained properly**
- AED pads from Zoll at the beginning of the course
- Understanding slideshow

Participants' favourites elements of the course

- Teamwork
- Scenarios and role playing

Favourite AED training devices

Philips, HeartStart FR2, Trainer 2 by Leardal



- "It is intuitive and user friendly"
- "It is robust, easy and it is the one I have learn first"
- "When training battery is put out and it is an operation tool. I enables to practice battery failure and it is easy to change scenario"



ZOLL AED Plus Trainer 2

- "I like to show Zoll, to show different types of pads"
- "It is interesting, pads are different"
- "It is really easy, it has remote, pictures, voice prompts"

Improvement in AED training equipment

- **Need of checking batteries before the course**
- Always taking additional batteries
- Always taking additional pads "They get dirty or stick, and when someone will stick them together and you can not peel them"
- They should be simpler
- Difficult to restart scenarios
- Too many scenarios "I photocopy the list of scenarios with remote control instruction. Laminated it and I to use it during a training"
- Training pads
- Remote the there is more devices "Remote communicates with different device that I want
- Metal stripes on mannequins cause troubles x2 "If you don't have metal stripe, participants have to stick pads together. It is wrong"
- Possibility to update software when it is needed

- AED pads mockups (first aid training)
- light weight, very thin and static
- It is not visible that there is a cable "People think pads are wireless" Sara

Additional information

Paediatric mode in AED training device "AED should be included in paediatric first aid course and AED should allow to do it"

Synchronising AED devices "With Zoll we can synchronised devices and they work at the same time. Less voice prompts mess"

Summary

What is the essential knowledge to demonstrate proficiency in AED use?

- Emotional: give confidence, empowered to act, get rid of fears
- Cognitive skills: awareness of limited time, safety features
- Technical skills: pad placement, a combination of AED and CPR, following the voice prompts

What teaching methods are used?

- Use a variety of methods to address different participants
- The importance of participants introduction element in instructor decision making about the speed and difficulty of the course.
- Change methods based on the group dynamic and participants experience.
- Although training institutions recommend their tools, instructors can still create their training and choose methods. They include: dancing, sabotaging scenarios, use comparisons to which they can relate, surprise.
- The essential teaching method is practice
- Conversation and practice are used to address the emotional skills of participants.
- Assessment is an integral part of the training. The instructor does it, but also, peer assessment is used.
- Positive and negative feedback is combined not to discourage participants
- Encouraging self-reflecting by asking questions could be used instead of direct feedback

How AED devices is used during training by instructors?

- Multiple instructors are sharing AED devices.
- Used for practice in teamwork - group of 2 or 3
- Always in combination with the mannequin.
- Scenarios are changed to make participants think and understand the AED use
- The decision about which AED is used during training is made based on instructor preferences, equipment availability but also the AED model own by a company where training is provided

What properties has desired AED device from instructor point of view?

- Reliable and robust device
- Simple and intuitive
- Durable pads
- Possibility to easily and fast check the battery status
- Easy to reset settings before the training
- Easy and reliable control with the remote especially when there are more devices
- Additional elements such as metal stripes are problematic for instructors
- Show tow types of pads (regular and Roll pads)
- Paediatric mode

Observation of courses in St John Ambulance

Two different courses were observed at St John Ambulance. The first was AED course and the second one was first aid course. Courses were selected based on the availability, include AED training.

1. What is the context of the AED training? (set up, number of participants, noise, space, time)
2. What teaching methods are used during AED training? (needs of training)
3. How AED device is used during a training by instructors? (the role of AED unit in the training)
4. How participants interact with AED device? (evaluation of interaction / AED interface, participants needs)
5. Does AED device supports obtaining learning objective?

AED course

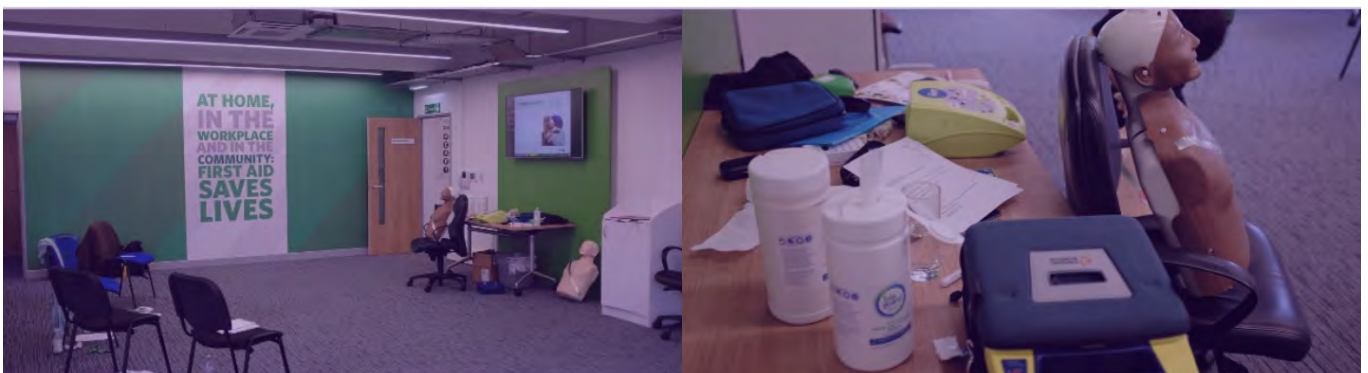


Location: London Bridge
Duration: 2 h

Instructor: 1
Participants: 4



Equipment:
2 mannequins
3 training AEDs
1 real AED





Training methods:

Theory: presentation, lectures, videos, discussion
 CPR: individual and group practice (a group of 2)
 AED: videos, demonstration, practice

- Use body language to explain tasks, or to remain participants about their mistakes and to support them
- Questions used both to stimulated participants, guide, give feedback, encourage to reflect, to engage and to asses knowledge
- Acting both as victim and bystander and exaggerate reactions and behaviours to entertain scenarios or explain symptoms
- The instructor is multitasking. She supervises participants an at the same time clean and prepares equipment between exercises
- Participants were kept continuously active (change the place from chairs to stand next to the board, practice on the floor)

Addressing emotional needs

- Emotional weigh of providing first aid, and an instructor addressed the aftermath.
- Give statistics and explain the limited power of first aid providers.

Assessment

- The instructor is participating and interacting with participants during exercises, she is a 3 actor or director of the scenario so she was able to observe and asses simultaneously

Feedback

- Provided during exercising
- Question participant "What are you doing? Is it effective? What do you think is a problem?"
- Positive encouragement "fabulous", show tams up
- Combination of positive feedback and negative when it is necessary

Course atmosphere

- Make it informal
- Say jokes
- Keep it fun
- Stay on the participants level (sit on the chair, floor)

- Questions are always welcome
- Comforting
- Friendly

AED

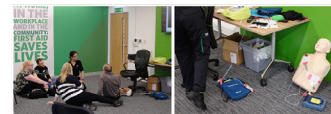
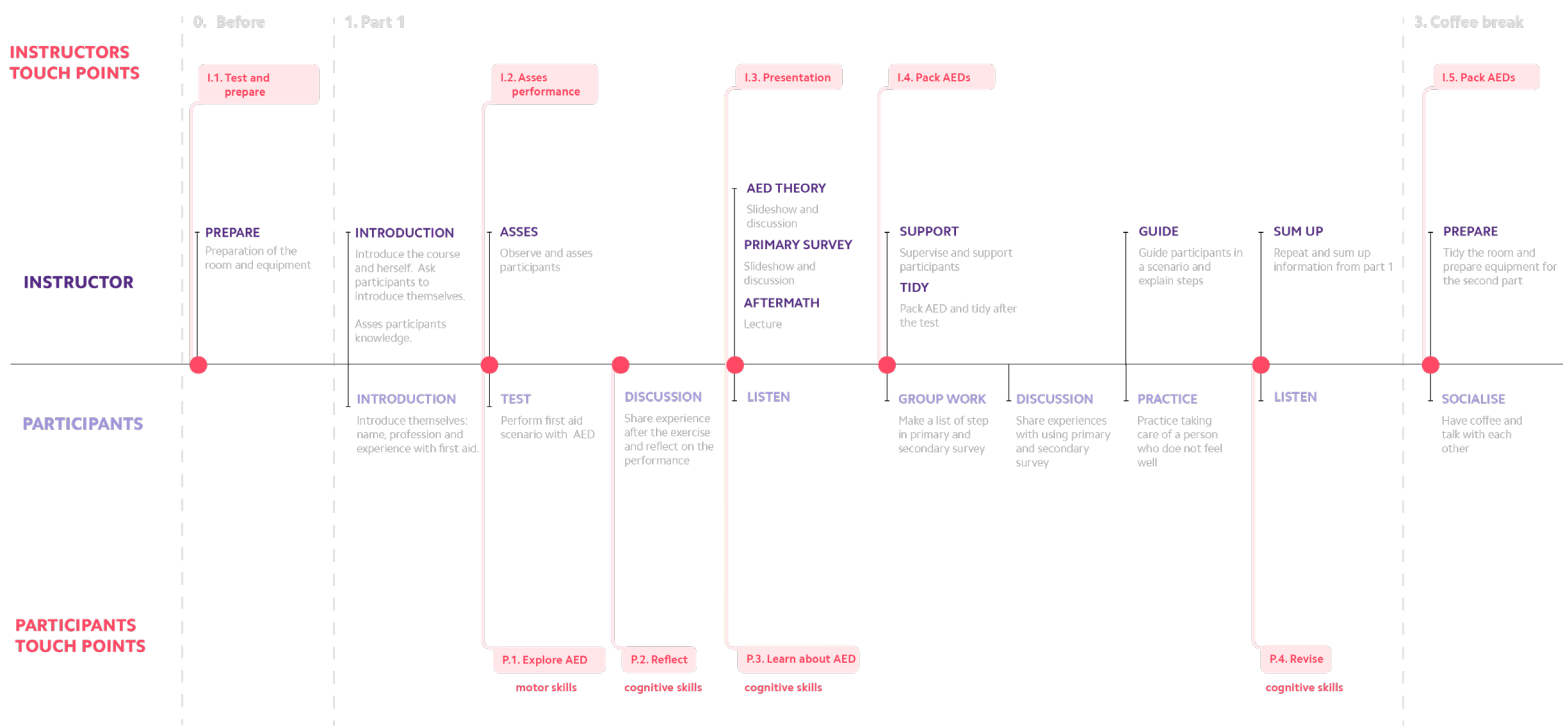
- Use "defib" not AED
- Paediatric mode was not mentioned
- practice only semi-automated AED use with only one scenario "shock advised"

Participants

- Seek confirmation from the instructor while exercising
- Interact mostly with the instructor, less with each other

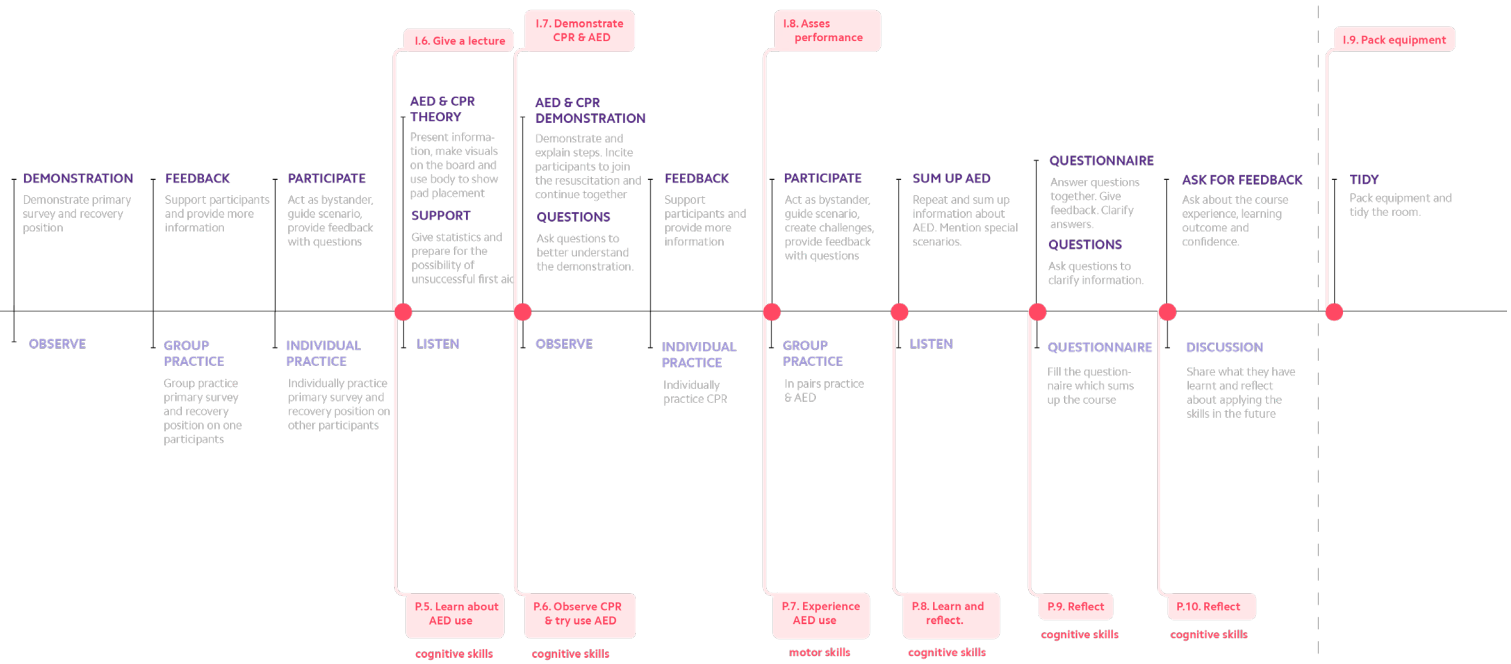
Participants' struggles during a course

- Forget to turn on the device and start placing pads x2
- Not hear voice promos as it was loud (second AED and instructor voice)
- Stop CPR while attaching pads
- Forget to say stay clear
- Change the previous knowledge (repeat the same mistakes)



4. Part 2 „Time for fun“

5. After



Instructor asked multiple questions to repeat the material from the first part of the course.

Break

Participants had coffee and talked with each other

Instructor tidied equipment and prepared everything for the second part of the course

Part 2 "Now it is a time for fun."

Introduction to the second part

Instructor repeated and summarised what they have done and explained what the next steps are.

Scenarios were explained to observe that they are breathing

Demonstrate a primary survey and recovery position

The instructor demonstrated a primary survey and recovery position on one of the participants. Others were observing.

Group practice of primary survey and recovery position

Participants in a group of 3 practised primary survey and recovery position on one of the participants. The instructor was giving advice and adding more information.

Individual practice of primary survey and recovery position

Two participants practised primary survey and recovery position on other participants. The instructor was acting as a second bystander, and at the same time, she was giving advice and asking questions when someone made a mistake. Later they have changed with each other and repeated the exercise.

AED and CPR theory

Instructor repeated the steps of AED use and used body language to show pad placement acting like a victim. She added more information about special situations by asking questions and helping participants answer them. She drew the heart chart to explain what is cardiac arrest, electric heart activity, and what is the effect of CPR and AED on it. Also, she used hands to describe how the heart works.

Explain that the survival rate is low, and even although the best attempts of first aid provision, it could be fatal. She told them not to blame yourself as they did their best.

CPR and AED demonstration

Firstly, the instructor demonstrated CPR and explain the steps. Next, she did it again but asked one participant for help with CPR and second to bring a defibrillator. She guides others on what to do. Asked other participant to come closer and observe.

Questions

After demonstration instructor answered participants questions about steps, AED and pads.

Cleaning

Instructor whipped off mannequins and prepare two stations.

CPR individual and group practice

Participants individually practised providing first aid. Two participants provided CPR while others observed and acted as a second bystander who calls EMS. Instructor guided participants and gave feedback about chest compressions, ventilation. They have changed, and with the second group, they started to work as a team and switch with chest compressions.

AED group practice 1

While participants were still providing CPR, the instructor acted as a third bystander and brought AED to the scene. One person continued CPR while the second pretended to cut clothes, turned on AED and follow voice prompts. Instructors guide and give feedback to participants.

Cleaning

Participants whipped off mannequins, and before they have changed.

AED group practice 2

Participants swiped over and started the scenario again. Teamwork is important.

AED conclusion

Repeat pad placement and describe it on the mannequin. Explained mistakes and special scenarios. It was also a time for participants to asked additional questions.

Questionnaire

Participants were asked to fill in the questionnaire. Instructor, read the question and ask participants. They answered it together, and she explained the answers.

Questions

Instructor asked if there are any other questions.

Sum up

"Is everyone happy about what they have learned today?" Do you feel you could do it for real? - Yes. Give a few more advises, joke and everyone said thank you to each other.

Cleaning

The instructor had to tidy room, pack equipment and put it to the storage place.



First Aid for adults

Location: London & South HQ

Duration: 2 h (observation of AED part - 2h out of 7h)

Instructor: 2

Participants: 22



Equipment:

9 mannequins

22 pairs of paper electrode pads



Training methods:

Theory: presentation, lectures

CPR: individual and group practice (a group of 2)

AED: presentation, demonstration, practice

Addressing emotional needs

- No at the observed part of the training

Assessment

- People practising on the back of the classroom received the feedback as the last ones even though there were
- There were gaps when none was observing participants

Feedback

- Provided during exercising
- There were gaps when none was providing feedback to participants
- Only one instructor was providing feedback at a time
- People practising at the end of the room received feedback late at most of the time of exercise made it incorrectly

Course atmosphere

- Intense
- Make it informal
- Say jokes
- Keep it fun
- Create funny names for parts of the exercises "gorilla pose" "power rangers."
- Loud while practising (people chatting)

AED

- A short part of the course
- Insufficient equipment to learn all recommended skills
- Paediatric mode was not mentioned
- practice only use of semi-automated AED with only one scenario "shock advised"
- No presentation of real size device
- Paper pads are not connected with electrodes

Participants

- Interact between participants was different depending on a group what affected the amount and quality of peer assessment

Participants' struggles during a course

Participants were following instructions correctly, but due to the lack of AED, there was no support to conduct some steps.

- Never turn on the device
- Follow the voice prompts but with gaps and delays as they had to say them on their own
- Stop CPR while attaching pads
- Forget to say stay clear
- Forget to press the button to deliver a shock

Course timeline:



Chain of survival theory

Importance of oxygen for the functioning of the brain was explained as the introduction. Further, the steps of the chain of survival were listed and described.

AED introduction

The instructor asked multiple questions "What AEDs is? Where could it be found? If participants saw it?" and responded to participants answers.

Heart theory

The instructor explained with hands how the heart works properly and what is its malfunction. To help participants understand it, a group exercise was done. Participants were instructed to move hands up and down to follow different heart patterns, and defibrillation was explained based on heart behaviour. It was an exercise, and many participants had a laugh.

AED theory

The instructor asked multiple questions about the defibrillator use and responded to participants answers to confirm them, or to deny. Next, he listed the steps of first aid and asked participants to repeat them loudly.

CPR demonstration

The instructor demonstrated the first aid but was guided by participants. He made intentional mistakes and waited if they would correct him. Asked participants to clap and that defined the correct compression rate. The instructor repeated the exercise one more time doing it correctly.

CPR tryout

Participants were divided into a group of 2-3 to use one mannequin and make turns. The first group followed the instructor, and the rest was sitting and observing. After a while instructor started to walk around and give feedback. It was repeated with other groups. Multiple people had a problem with depth and rate. The correct release was impossible to observe and assess. The instructor gave feedback to everyone individually, but some participants still didn't reach the correct CPR. The second instructor switched with the first one to provide feedback.

CPR practice

Participants in the same groups were instructed to act out the first aid scenario with CPR. One person from the group performed exercise and others assess him/her based on the assessment sheet and provided with feedback. Some groups whose participants struggle with CPR were not able to provide good feedback to each other.

AED use

The instructor explained steps of AED use. There was a strong focus on pad placement. The exercise was done in which participants were asked to place hands on their own chest in the correct position of pads.

AED demonstration

The instructor demonstrated the first aid scenario with CPR and AED, the second instructor was a bystander who brought AED and attached pads. The presentation was used with the voice prompts recording to mimic AED.

AED practice

Participants in the same groups were instructed to act out the first aid scenario with CPR and AED. One person from the group performed CPR and second used AED, and the third one assessed them based on the assessment sheet and provided with feedback. Simple paper electrodes were used and no AED model. They didn't stick well to the mannequin, so they were moving around and were not precisely placed. Participants had to pretend voice prompts which they didn't remember well. Some people got confused about what to

say caused delays. As a result, only one scenario was practised with successful delivering shock. Also, as there was no AED, there was no practice of turning it on, and some of the participants didn't pretend to press the button to deliver a shock. There was only small feedback from instructors and other participants.

Questions

At the end of that part of the course, the instructor asked participants if they have any questions.

Summary

What is the context of the AED training?

AED training and first aid training are placed in a different context

AED training

- Has small number of participants (4-6)
- Medium pace adjusted to the participants
- Participants receive high instructor attention
- Only instructor based feedback
- Everyone is gather at the same spot as the space is small but adequate to the number of participant

First Aid training

- Has a high number of participants (22)
- High pace, intensive
- Participants receive small instructor attention as it is divided among bigger number of participants
- Only instructor based feedback
- Participants are spread around big room what requires walking from instructor and affect the possibility to observe everyone (the view to the participants in the back is block out by first row of participants)

What teaching methods are used during AED training?

- Importance of Introduction to adjust the level of the course
- Additional test was done to define participants starting point but also as a stimuli to experience the situation before learning the theory
- Mixed of different methods was used
- Strong focus on practice
- With bigger number of participants group activities which include the whole class were introduced such as heart malfunction exercise or repeating together the steps

How AED device is used during a training by instructors?

AED training

- 2 types of AED are used. More complex for the demonstration and the more simple one for practicing.
- Every participant has a chance to multiple times try AED
- They do it in a group od 2

First Aid training

- There is no AED device
- Paper pads with glue on the back are used
- No vice promos or feedback

How participants interact with AED device? (evaluation of interaction / AED interfcie, participants needs)

AED training

- Step to turn the device on is tricky, participants start with pads and there is no feedback aside from the instructor

First Aid training

- They don't interact with the device physical device
- Try to mimic it partly (say voice prompts, invisible button)

Does AED device supports obtaining learning objective?

AED training

- Yes, it mimics the functionalities of the real one
- It has a bigger potential which was is not used (more scenarios)
- Sometimes participants makes mistakes which are not spot by instructor

First Aid training

- Lack of physical device for demonstration could makes participants not allowed to get familiar with the device and could create a foals image of it
- Lack of physical device for practicing result in no background for practicing some of the skills
- Practice with paper could not give the confidence of using real AED

6. Qualsafe headquarter in Bradford, UK



Short, semistructured interview was conducted with two employees from Qualsafe. Participants were selected based on the availability, willingness to participate in the study and experience in providing AED training. Interview questions (AppendixX) were prepared based on the the main research questions.



Importance of AED training

- Gives confidence
- Improves performance and reduce the risk of error
- Teaches good quality CPR

Teaching methods

Peyton method of teaching practical skills:

1. Live demonstration
2. Deconstruction, explain what you are doing, why,
3. Students guide instructor what to do
4. Students practice themselves

Importance of assessments

"Assessment should be informal and blended within a course"

"If instructors don't assess people correctly, don't teach correctly"

"Pad placement can be easily judged by instructor observation"

Blended learning

It could be used for theory.

According to the guidelines only 1/3 of the course can be online.

Key skills

- Turn on
- Correct pad placement
- No delays in CPR

AED training devices

- Visible dominance of generic AED devices. "People tend to use generic trainers as there is no reason to spend that amount of money, and you can not be sure that that client will have that particular model"
- Multiple cheaper devices used for training and one bigger, branded for presentation.
- Switch pads to the cheaper and more durable ones.



Most popular AEDs

Mini AED Trainer "It is the cheapest and the smallest" [REDACTED]

Universal AED Practi Trainer

"It is the cheapest and the pads are good quality, plus it can be used multiple time" [REDACTED]



Complains

- Pads price
- Pads quality
- Volume malfunction
- Remote connectivity

Improvement in AED training equipment

- Not fully adhesive pads to help detach them from the mannequin
- Durable pads "All you want from the decent pad is to stick" [REDACTED]
- Pads should be simpler "Don't over engineer"
- Lightweight and small "not too bulky" [REDACTED]
- Simple



Additional information

Simple tools for first aid games

- Quiz about first aid
- Inflatable ball with questions

Paediatric mode

"There is a rise of awareness within younger generation of parents. Wee saw a lot of children dying on the field." [REDACTED]

Instructor image

"I don't want to look stupid" [REDACTED]

"Philips too technical and can embarrassed the trainers" [REDACTED]

Summary

What is the essential knowledge to demonstrate proficiency in AED use?

- Technical skills: efficient AED use, CPR
- Emotional: give confidence

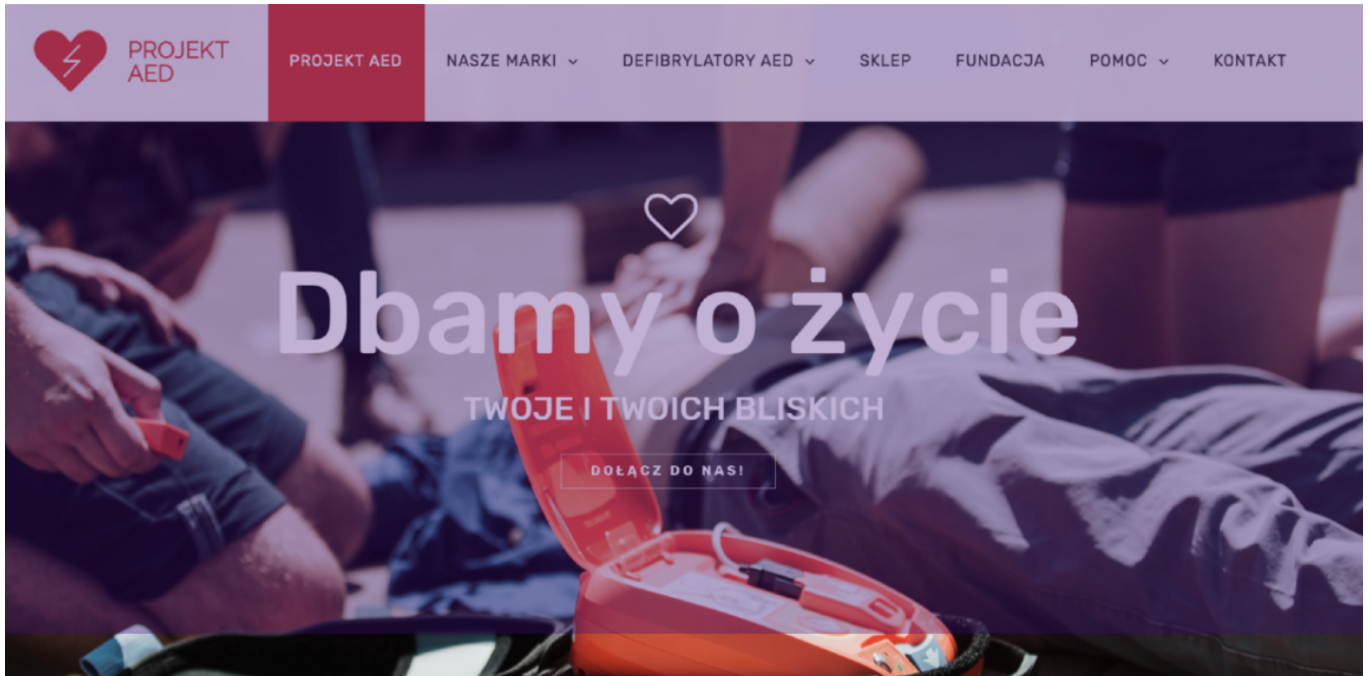
AED training devices market

- Dominance of generic models due to the price difference and timelessness
- Price and size are main buying factors

What properties has desired AED device from instructor point of view?

- Simple and intuitive not to embarrassed the instructor
- Small and lightweight to facilitate transportation
- Durable and cheap pads

5. Projekt AED



At the beginning of the project office of Project AED in Kraków, Poland was visited. It is a company which distributes AED devices and provides AED training for the clients. A semistructured interview was conducted with Tomasz Mazur, who is the project coordinator and a certified first aid instructor. The aim was to understand the market of AED devices used in emergency and its connection with first aid training.

Type of course

CPR + AED

When company or institution purchases AED device, training is provided to get employees familiar with the device and first aid. It is a short training which focuses on AED but also includes CPR. The course provides Emergency First Response certificate.



Location: at the client facility

Duration: 2,5h

Instructor: 1, **Participants:** up to 16



Equipment:

4 mannequins, 1 training AED, 1 real AED device, mat, AED signs, face masks for ventilation

Teaching methods

- Theory
- Videos
- Practice
- Teamwork
- Observation

Minimise theory “Minimise it not to discourage participants”
 Positive informations. Mention only dos without don’ts “Especially young parents start to panic when we tell them not to do sth. We only tell them what to do with strong applause.”
 Only positive feedback “It is recommended to applause participants even when they do some mistakes. It’s better that they are willing to act than be scared and do nothing.”
 Simple “Don’t mess in their heads.”



Most popular AED device

iPad by CU Medical System

- Proportion of price to the quality
- Paediatric mode
- Automatically adjust loudness

&

Favourite AED training device

iPad by CU Medical System

“It is simple, intuitive, no additional functions and has paediatric mode. It doesn’t scare with medical sounds and looks a bit bulky and toy’ish. Together it makes it feel friendly.”



Most popular AED training device
Universal AED Practi Trainer
 One of the cheapest on the market
 Low quality



Improvement in AED training equipment

- Decrease number of scenarios - 2 are enough
- Change scenario with remote, for example low battery
- Durable and cheap pads "Main maintenance cost is replacing electrodes. We convert the cable to replace only electrodes pads to cheaper and more resistant once (glue)"
- Integrated paediatric mode
- Pause button
- Rubber bottom to avoid movement
- Robust
- Possibility to update software
- Charging or standard batteries with easy access

- Combine and simplify remotes "One person cannot cover 4 remotes. We use one AED per group"
"Complicated, no battery indication, doesn't work in sun and often gets lost"

Future of AED devices

- Maintenance-Free
- Decrease in size and weight
- Decreasing prices
- AED management system
- Artificial intelligence
- Voice prompts in multiple languages

Additional comments

AED training devices are not adjusted for disable people

- no tactical guidance for blind people (both braille language and unify buttons shape)
- no visuals for deaf people

Summary

What is the teaching approach?

- Emotional: The main focus in the course is on the willingness to act and confidence. The methods used are: instructions only with aimed behaviour (dos), positive feedback and support.
- Cognitive: Theory is simplified not to overwhelm participants

AED training devices market

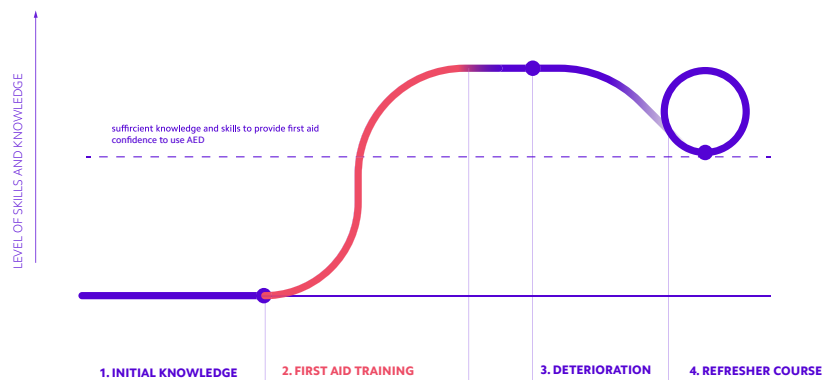
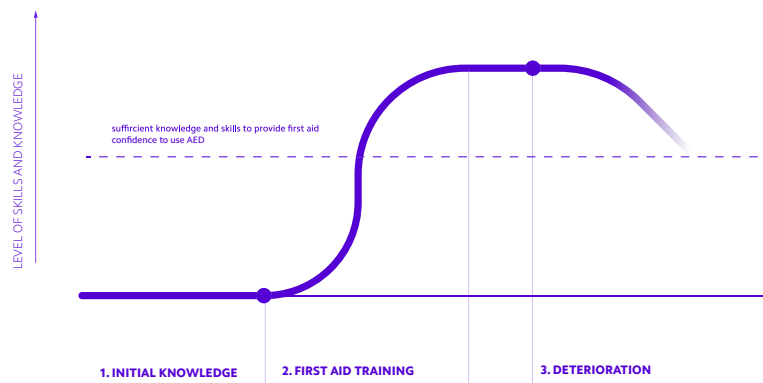
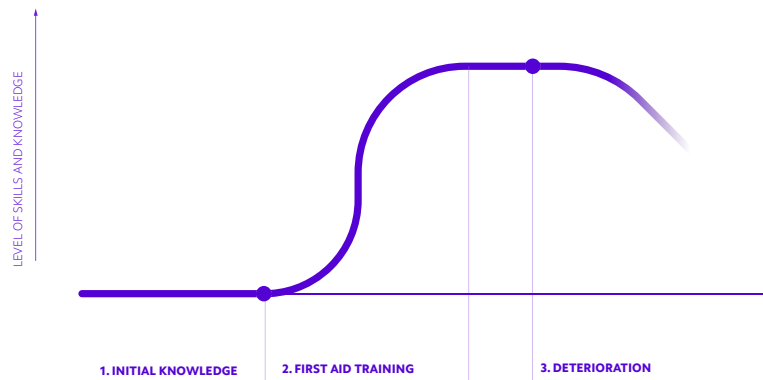
- Price and pads are the main buying factors

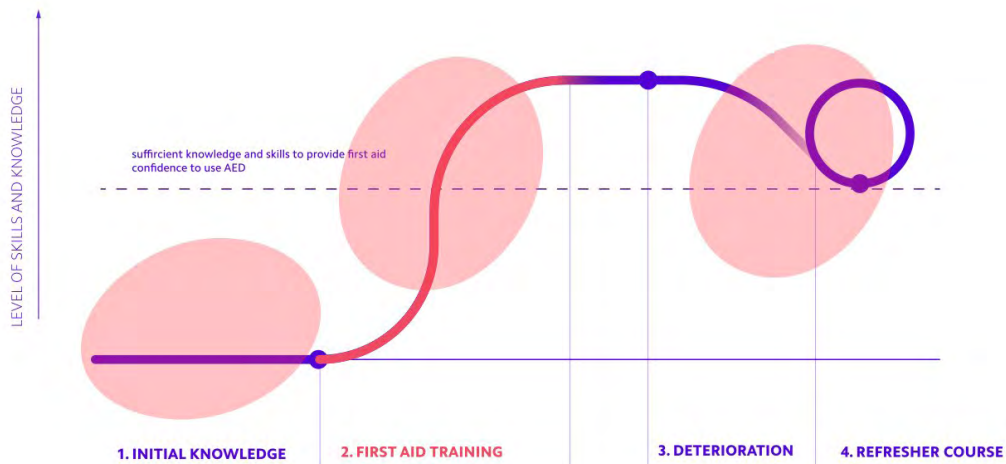
What properties has desired AED device from instructor point of view?

- Simple and intuitive
- Robust
- Durable and cheap pads
- Simple remote
- Integrated paediatric mode

6. Interview with participants

Short, semistructured interviews were conducted with seven participants. Participants were selected based on their knowledge about AED and experience with first AED training. Interview questions (AppendixX) were prepared based on the the main research questions.





1. INITIAL KNOWLEDGE (Without first aid course)



Deniz, 24
Student



Mikołaj, 23
Student / Intern



Martyna, 26
Graphic Designer

First Aid Experience:

- Basics first aid course, only CPR no AED
- High school, military, driving license, work
- 1, 5-7 year ago
- Do not feel the need to repeat the course, unless it will be provided by the employer and included in working hours
- Define current skills and knowledge as sufficient

QUOTES:

"Yes, but not now, I am too busy." Deniz

"It is difficult to remember something from that courses" Martyna

"I never had an opportunity or need" Mikołaj

AED image

- Do not know what exactly it is
- Knows that it provide electric shock
- Used when the heart stops
- Dangerous when used on incorrectly
- Delivers very strong shock
- It is the same as the one used by EMS
- Does not provides instructions
- The user decides when to deliver a shock - Not aware that it analyses heart and decides about delivering a shock

AED is:

- dangerous
- unknown
- complicated
- cold
- foreign
- not intuitive

Willingness to use AED

- Will avoid the need to do it
- Only when there will be some instruction
- Do not know when to use it - how to read pulse

QUOTES:

"I hope that I will never use it." Deniz

"I do not even know how to find it. What sign has it?" Martyna

"I would rather not use it. I will just do what I know." Mikołaj

Emotions toward using AED in emergency

- Anxiety
- Fear (hearting a person & consequences)
- Stress
- Responsibility

QUOTES:

"It is scary to do it because you can kill someone." Deniz

"I am afraid that I will hurt someone." Mikołaj

2. FIRST AID TRAINING (Currently participating in a first aid course)



Alicia, 22
Looking for a job



Eva, 19
Student



Matthew, 23
Looking for a job

First Aid Experience:

- 2/3 (12h) of an extended first aid course at Red Cross in Amsterdam
- Positive and good experience
- Read a book from the course
- Took notes
- Took video and recorded a voice not to forget
- Practice at home with friends, boyfriend
- Enjoy interacting with others at the course, meet new people
- Practical part (AED and CPR) are the favourite part of the course
- Motivated to repeat the course when certificated will expired

QUOTES:

"I enjoyed the practical part. It is the best way of learning, and you remember doing." Alicia

"I left the course excited, and I will practice and tell other people about it." Alicia

"It was a supportive environment; we politely help and tell others when they forget something." Alicia

"I was recommending it to everyone, it such a good pice of knowledge." Alicia

"if you do not take notes, you will forget". Eva

"I am quite proud of participating in the course." Eva

"I try to spread the word about it. It is not too hard." Eva

"I am looking forward to the last day when we will test the knowledge in scenarios, and I will see how much I have learnt." Eva

"I am usually shy, but I did feel shy there. We started at the same level, and the group was small." Eva

"Sometimes, I did not understand. It was too difficult with medical vocabulary." Matthew

"My favourite part was when I went to the front of the class, and I helped the teacher to demonstrate the exercise." Matthew

"I enjoyed the course. I am happy that we participated together and we talked like friends." Matthew

Motivation:

- Applying for jobs
- Feel a need to know the first aid."
- Recent experience which required first aid

AED image before the course

- Delivers shock
- Only for medical people

AED image

- Used when the heart has an abnormal rhythm
- A smart device which analyses the heart rhythm
- Know the meaning of AED abbreviation

"AED is a superhero." Matthew

AED is:

Lifesaving

Helpful

Smart

Wonderful

Necessary

effective,

useful

practical

innovative,

necessary
Essential important
wonderful
convenient
common equipment
amazing,

Willingness to use AED

- High
- It is straight forward
- Confident about skills
- Excited about the possibility to help people

QUOTES:

"Definitely!" "It makes a difference."

Emotions toward using AED in emergency

- Scared - the situation
- Try to focus on the task to minimise fear
- Excited to help
- Happy to help

QUOTES:

"I feel excited that I can help people to survive." Matthew

"I will be happy to help people." Matthew

3. DETERIORATION (Participated in a first aid course in the past)



Paulina, 30
Physician



Agnieszka, 35
Construction engineer

First Aid Experience:

- Basics and advanced first aid course
- Employer
- 1, 4 years ago
- Enjoys a practical part
- Would like to repeat the course in the future

QUOTES:

"It was nice that we could practice, but for me, there could even more practice would be better." Paulina

"Knowledge disappears." Paulina

AED image

- Used when a person is not breathing
- Provides small electric shock
- Guides the user

AED is:

- Practical
- Easy to use
- Necessary
- Calming
- Compact

Willingness to use AED

- High
- Practice multiple time
- Witness successful use of AED

QUOTES:

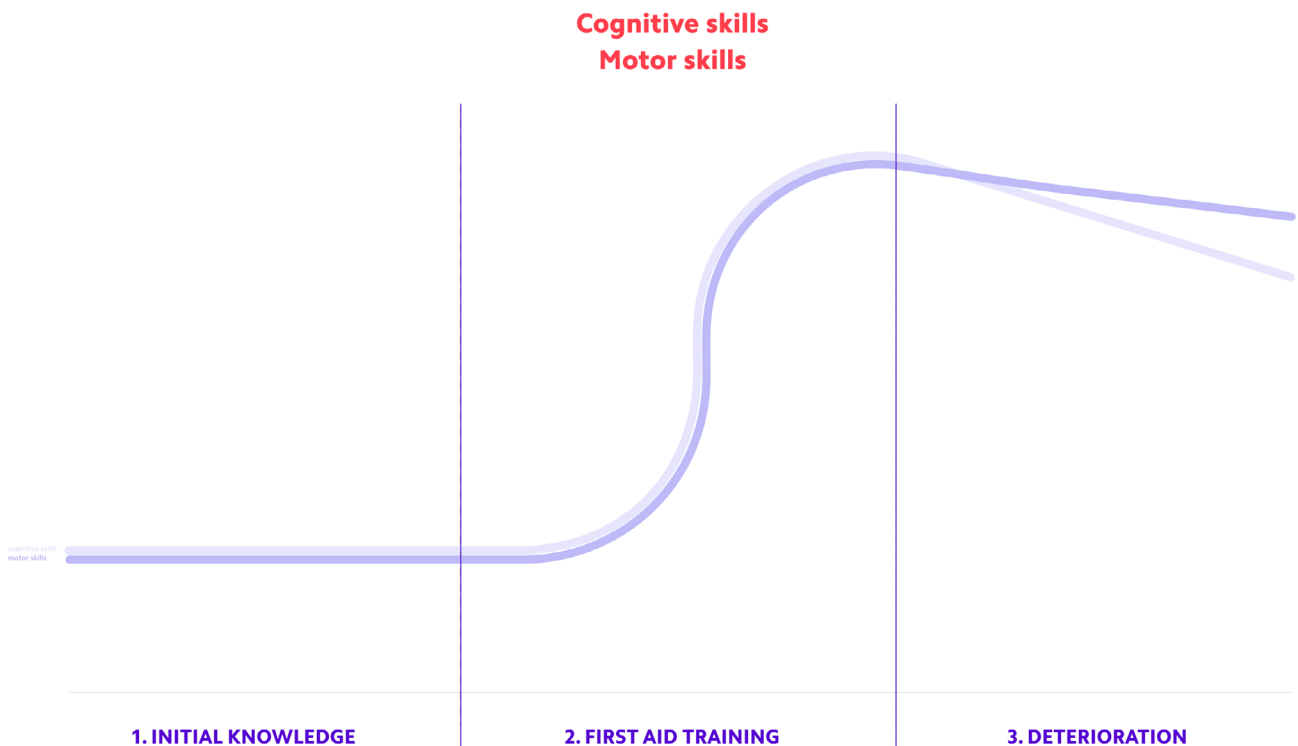
"Whenever there is someone unconscious, we immediately grab AED on the way and run." Agnieszka

Emotions toward using AED in emergency

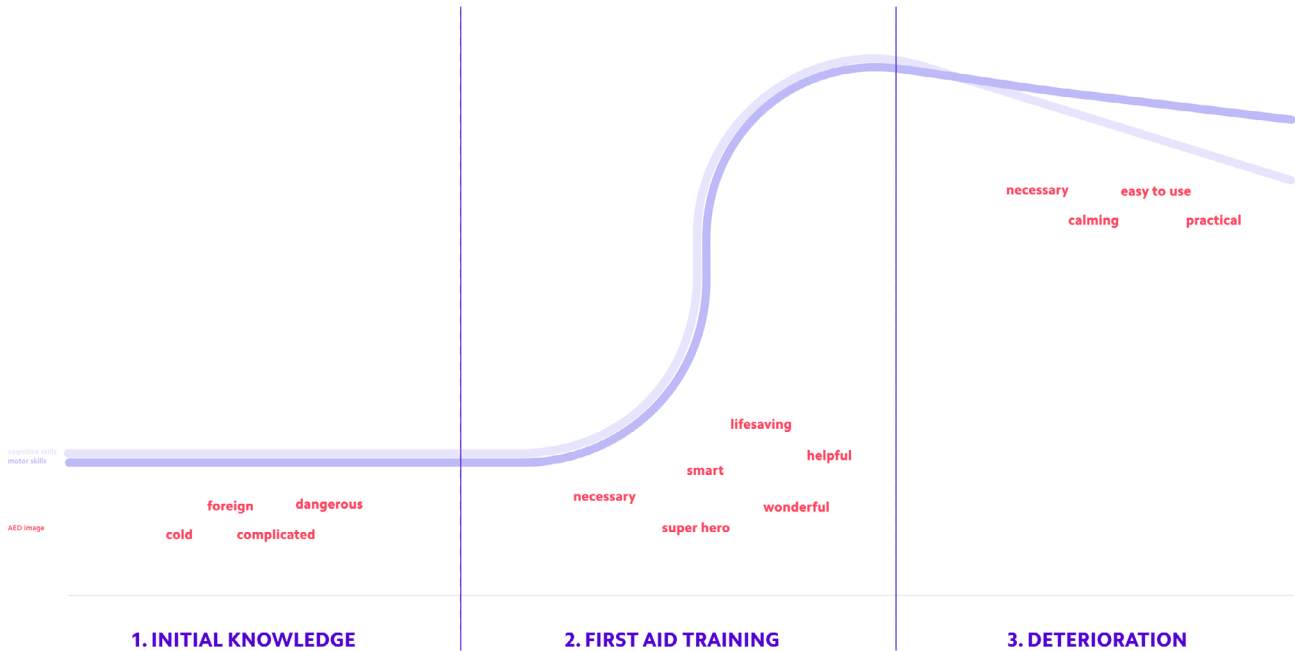
- Stress
- AED voice prompts will help to calm down
- Confident about AED help

QUOTES:

"I feel confident. I know that the device will help me." Paulina



Perception of AED



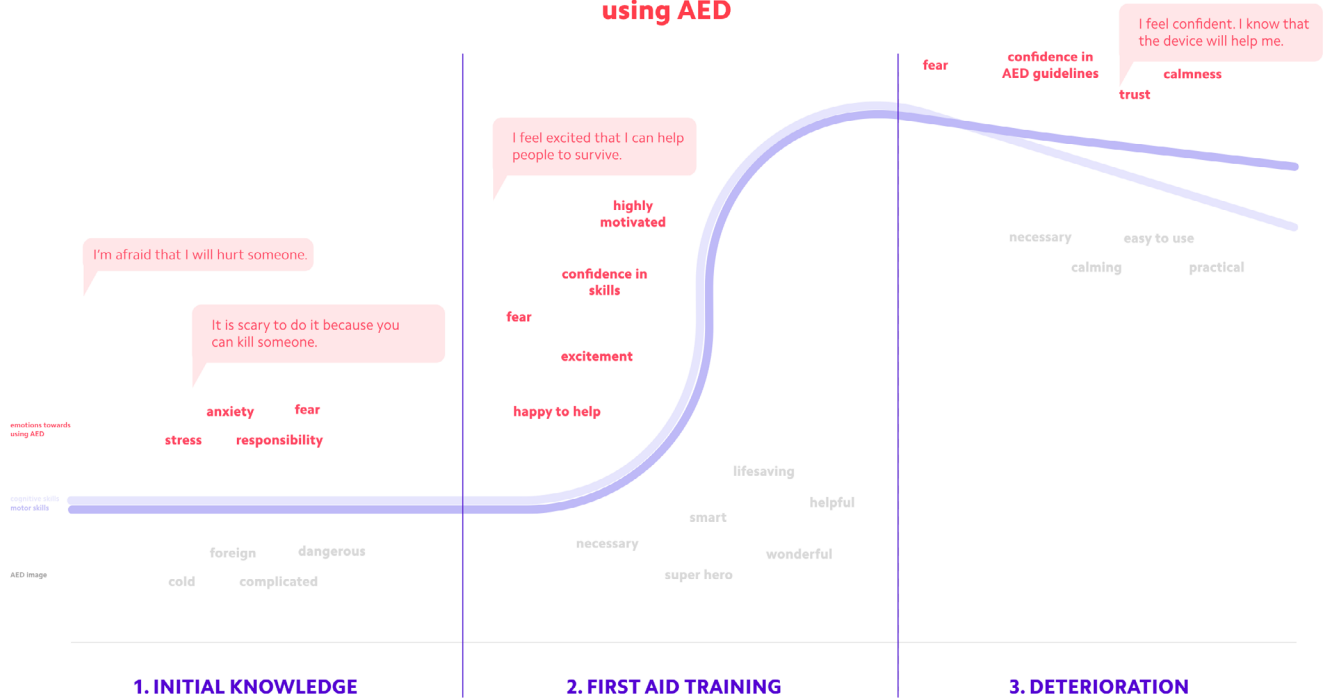
There is a significant shift in the perception of AED devices between people without training and people during and after it.

The first group described AED only with negative adjectives such as dangerous, complicated and cold. The reason is assimilating AED device with medical defibrillator used by EMS or in the hospitals. As a reason, they thought that it is a complicated device which requires medical knowledge to be operated. Besides, they believed that they would have to decide if the shock is recommended and deliver it. The shock was described as high and combine with the responsibility to deliver it they found the device dangerous.

The second group which is still during a first aid course but after the part about AED had a very positive image of AED, and there were excited about it. The most often used word was lifesaving and necessary. Fact and statistics about survival were used to underline how important it is for victims survival, also from the awareness of how AED, it was described as smart and helpful. Overall the potential of the device and its admiration is high: "superhero" and "wonderful".

The third group saw AED more analytically compared to the first group. It also had a positive image, but there was a bigger focus on operation "easy to use" and "practical".

Emotions towards using AED



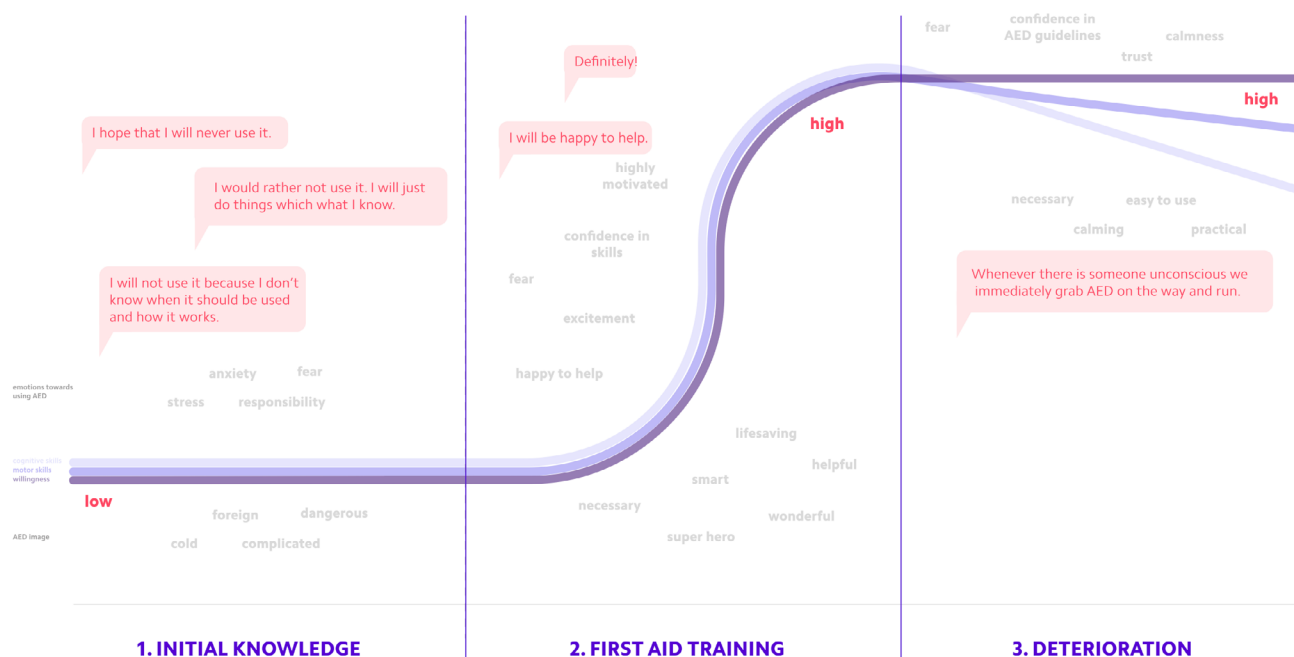
Fear was present in all groups. It comes from the stressful and emotional aspect of the emergency. However, then the second group said that their knowledge and skills would help them to stay calm, and the third group mentioned that being guided by AED will help them calm down.

Participants without trying were not aware of how AED work, and it resulted in anxiety about hurting the victim with AED. Also, they find the use of AED as a challenge which comes with a lot of responsibility and results in stress about consequences.

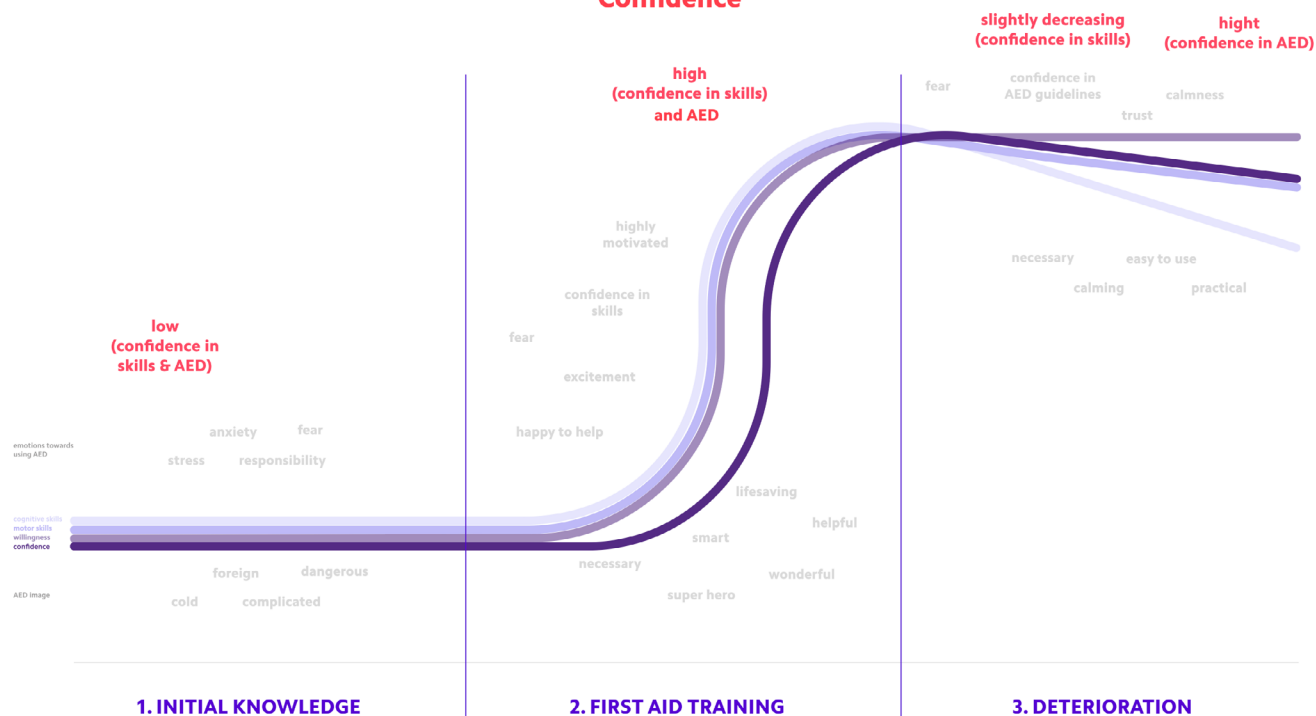
The second group was highly motivated and excited about the possibility to be able to use AED in the emergency. They believed that they could only improve the victim state, and we were happy that they could help.

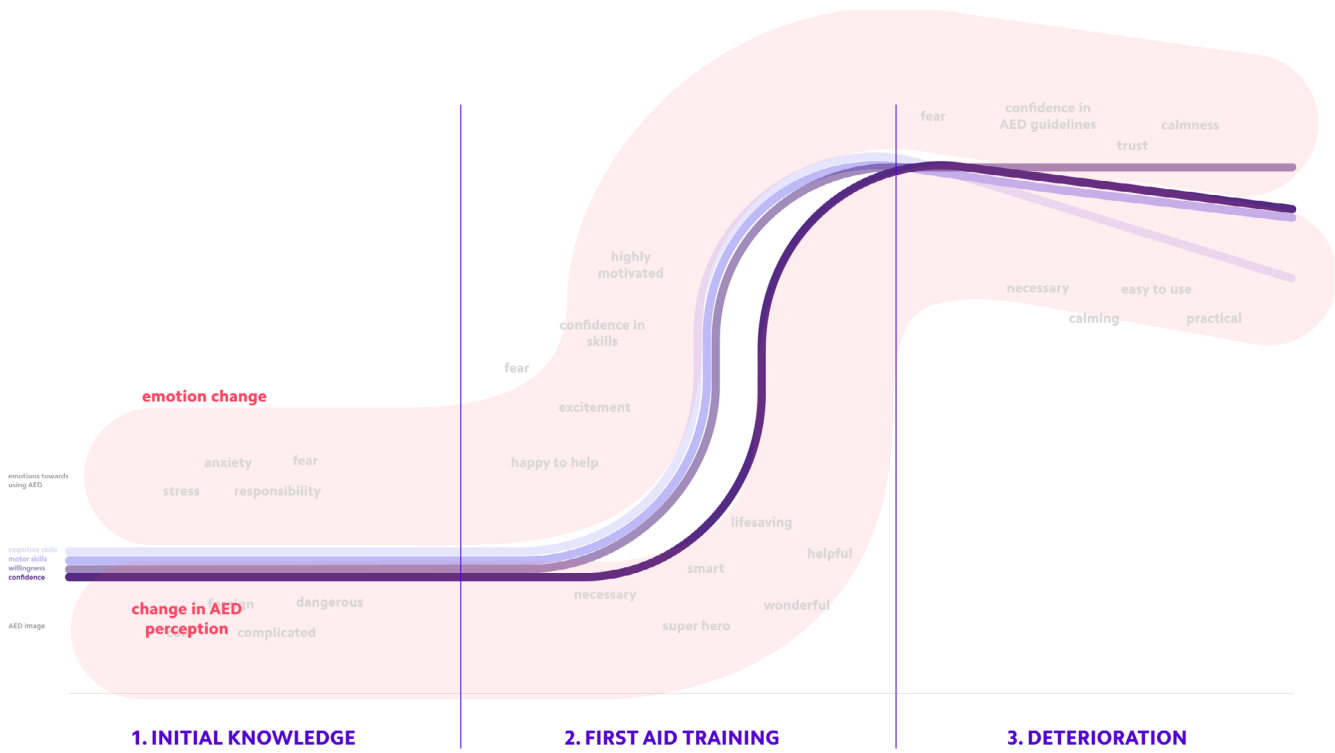
The third group was more reserved about the emotional aspect of the possibility to use AED, but they described the device as a source of all positive emotions. Willingness to use AED is low in the first group. Participants said that they would not use it or they would avoid the possibility to do it. The only possibility that they mentioned that they could do it was when some would guide them.

Willingness to use AED



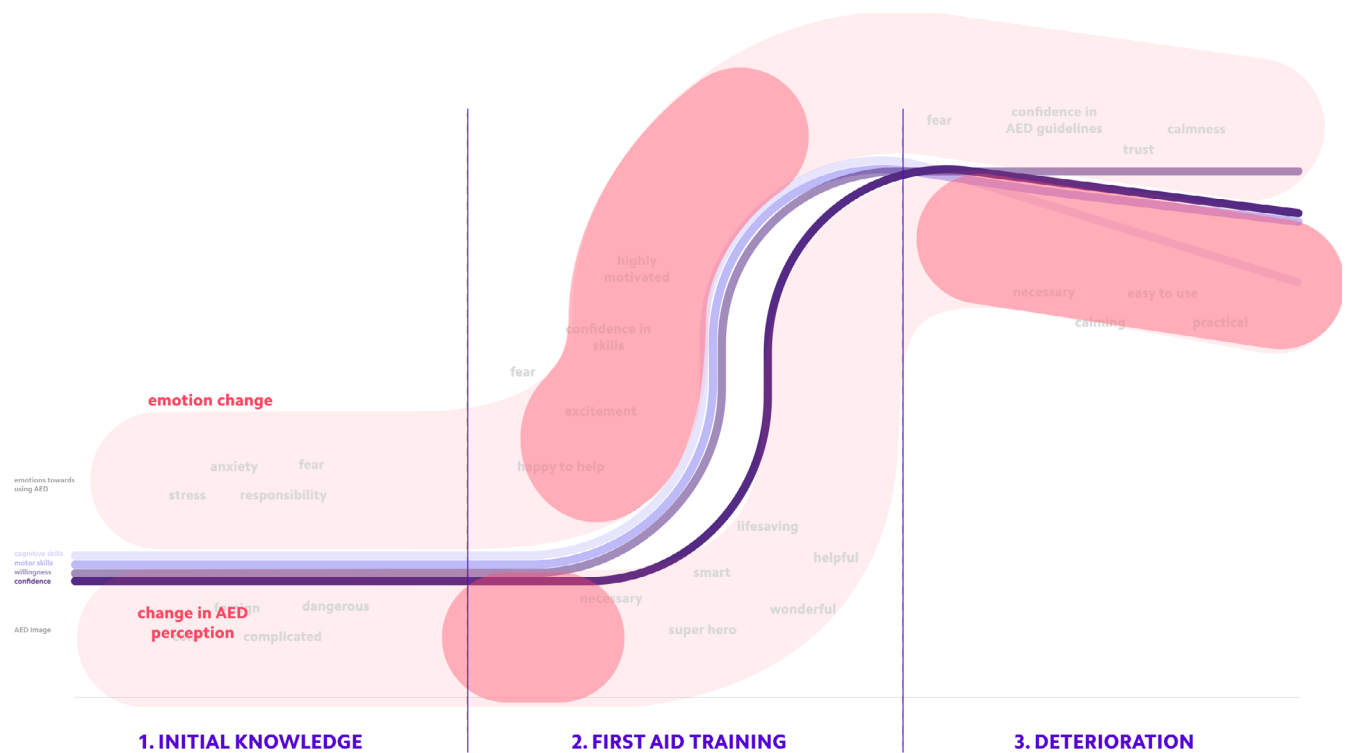
Confidence





Confidence in the device comes from the knowledge (facts, presentation about AED - it is safe, simple and it will guide the user) and from practice (mastering the use of the device with behaves in the same way).

There are two significant changes in participants. There is the shift in perception of AED from dangerous demanding device to helpful, superhero. Following the emotions towards using it are changing. Stress and anxiety are replaced by confidence and even excitement.





Change perception of AED

AED is safe, helpful, trustworthy, easy to use and smart

Change Feelings towards using AED

Gain willingness and confidence

Research conclusion

AED training have to:

Change perception of AED

AED is safe, helpful, trustworthy, easy to use and smart

Change Feelings towards using AED

Gain willingness and confidence

Equip with skills and knowledge

Provide participants with skills to achieve proficiency in using AED

It could be achieved by:

Practice

Practice with AED device helps change perception of AED and gain confidence

Assessment

Assessment is integral part of the training. It helps recognise the mistakes and define the accurate feedback.

Feedback

Constructive and positive feedback improves participants confidence

The challenges are:

Number of Participants

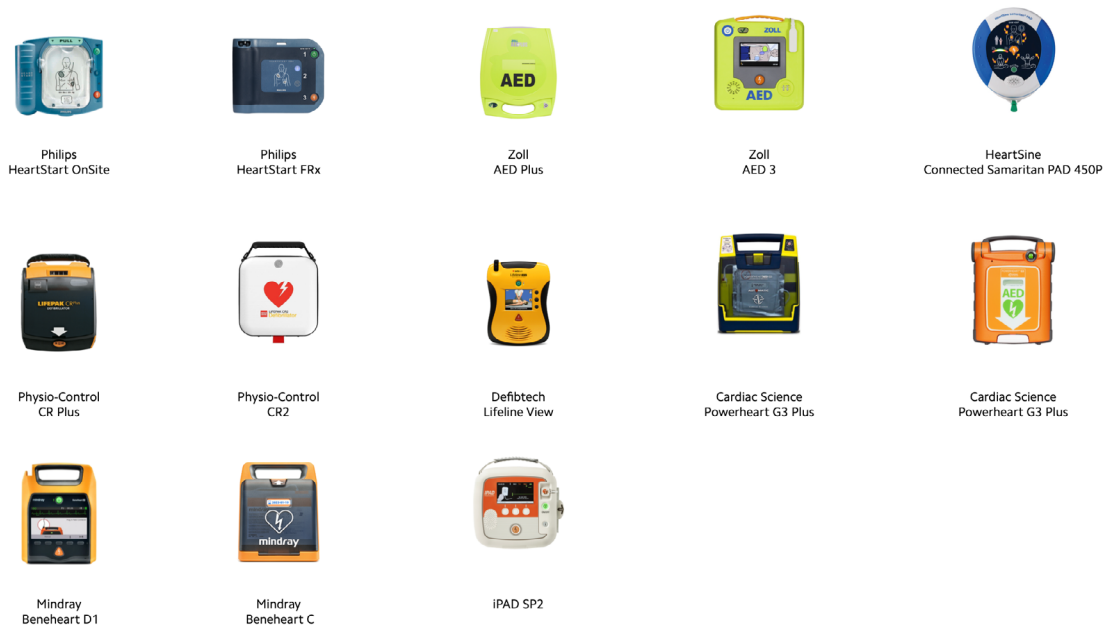
Limited access to the equipment
Group work is necessary

Instructor limitations

Limited possibility to assess and provide feedback to each participant

C. Product analysis

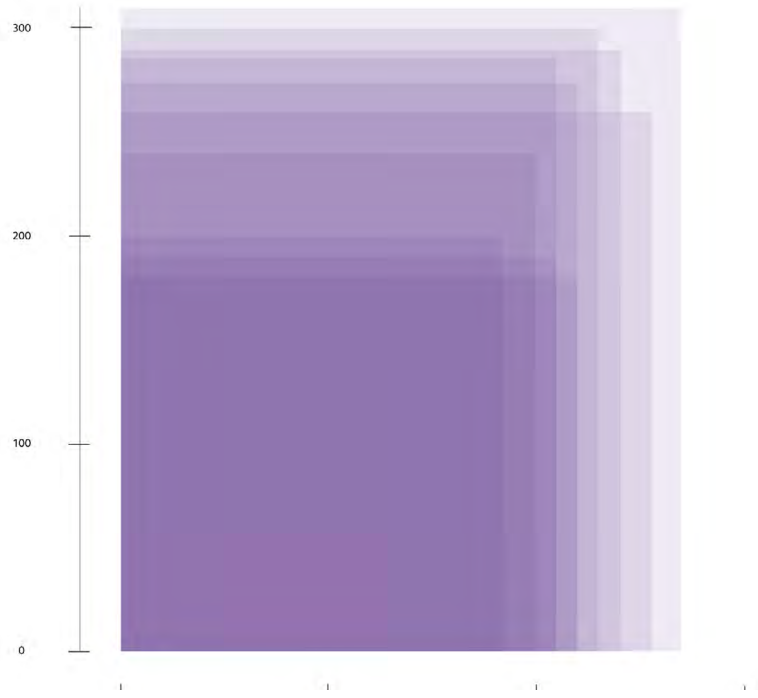
Product analysis of AED devices



Time line



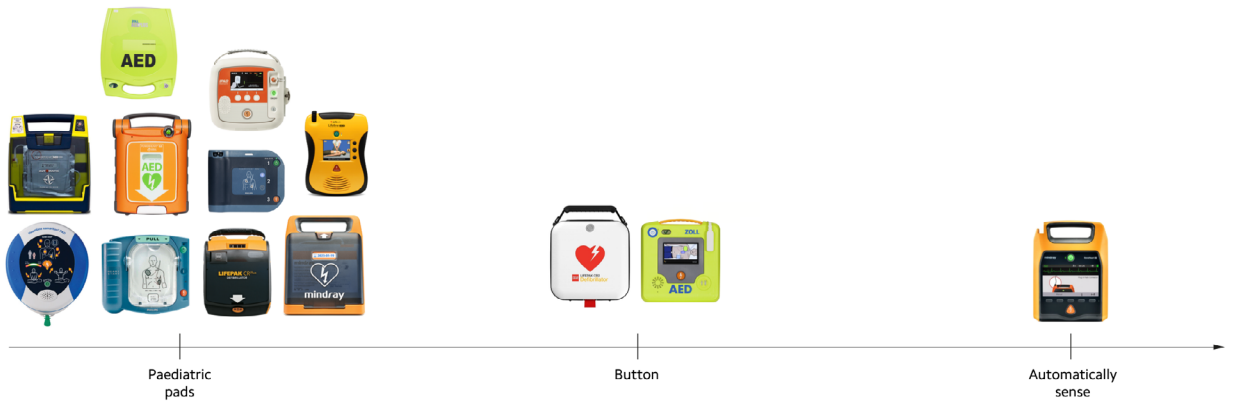
AED Size



Guidelines



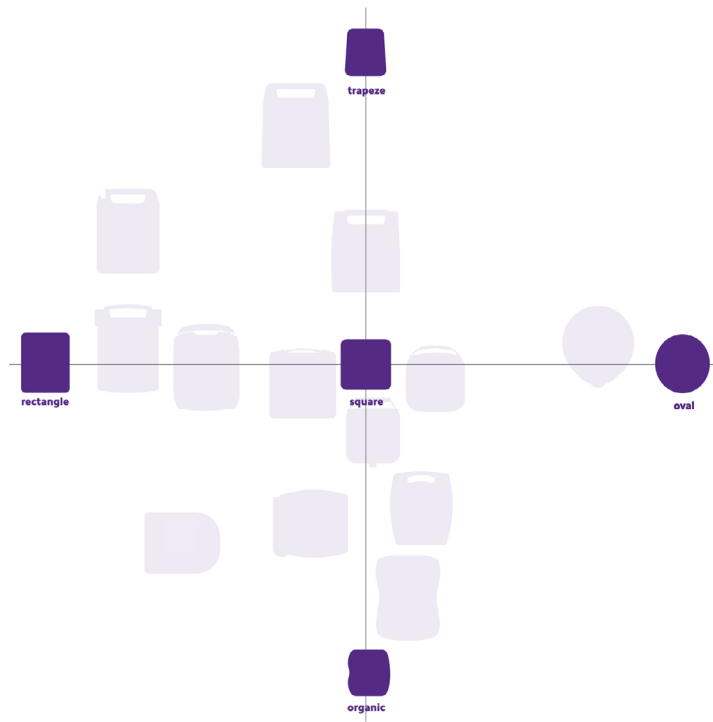
Paediatric mode



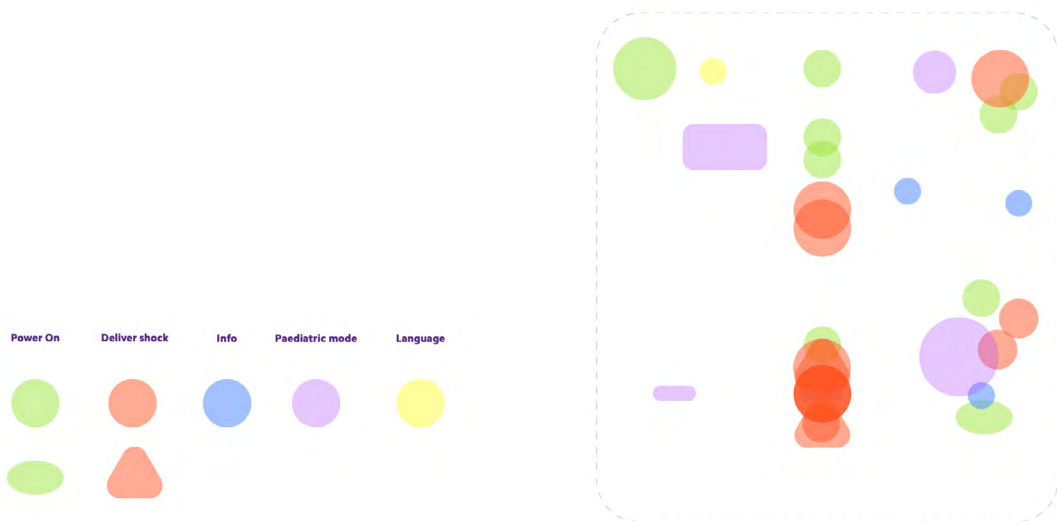
Aesthetic scale



AED shape



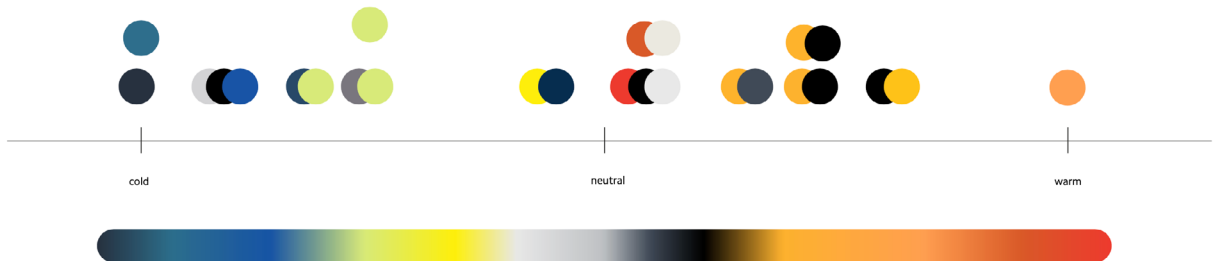
Buttons placement



Colour scale



Colour scale



Pads' shape



Product analysis of AED training devices



Laerdal Trainer 2



Laerdal Trainer 2



Zoll AED Plus Trainer



Zoll AED 3 Trainer



Cardiac Science Powerheart G3 Plus Trainer



Mindray Beneheart D1 Trainer



iPAD SP1 Trainer



Defibtech Lifeline View Trainer



Prestan Professional AED Trainer Plus



Prestan AED Trainer Ultra



Multiple (XTF / WNL) Trainer



Multiple (XTF / WNL) Practi-trainer



Meditech The Defi 1T AED Trainer



Multiple (XTF / WNL) Mini AED Trainer

Comparison



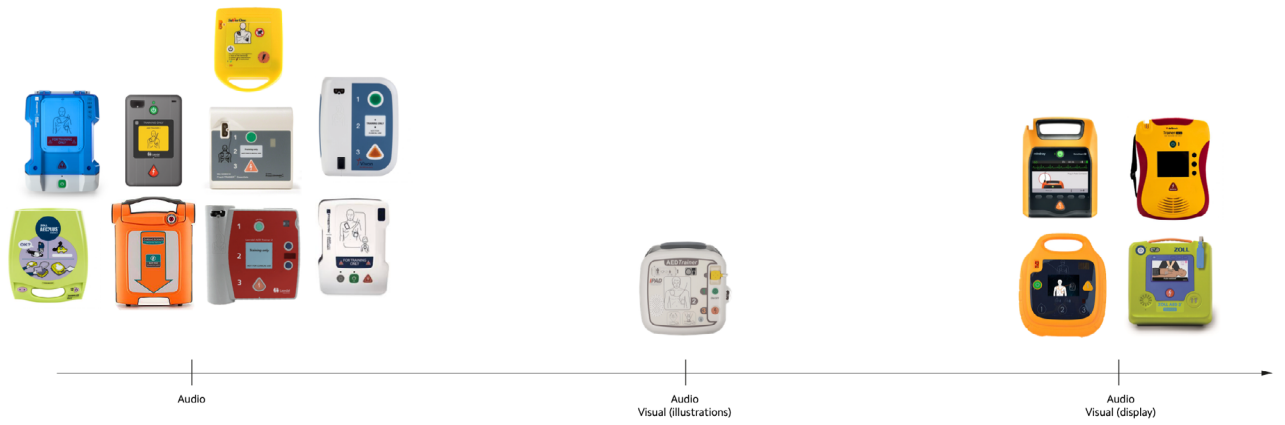
Time line



AED price



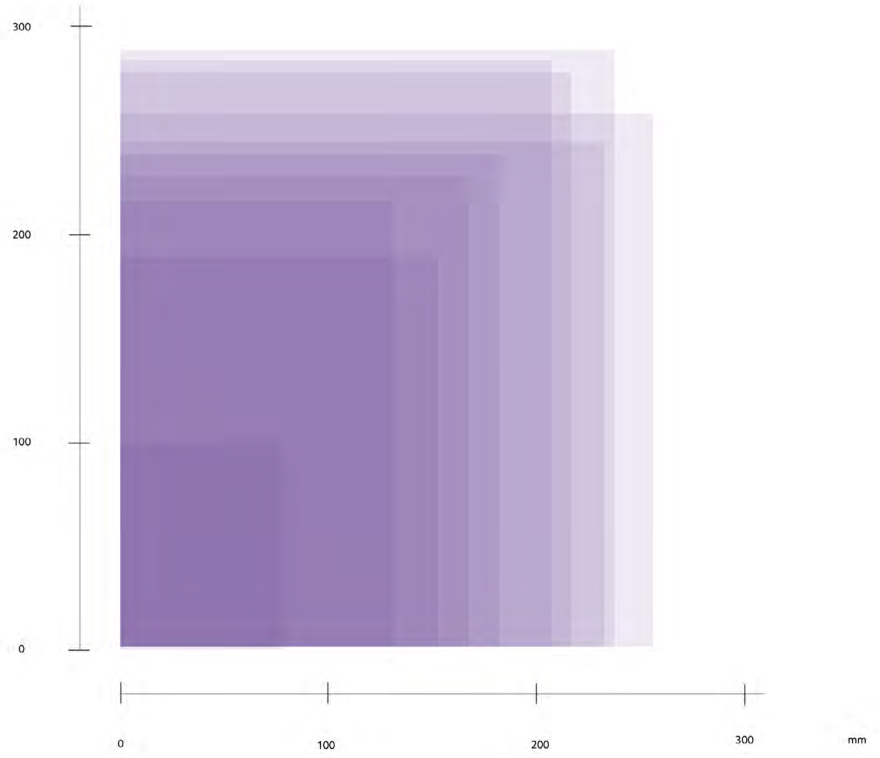
Guidelines



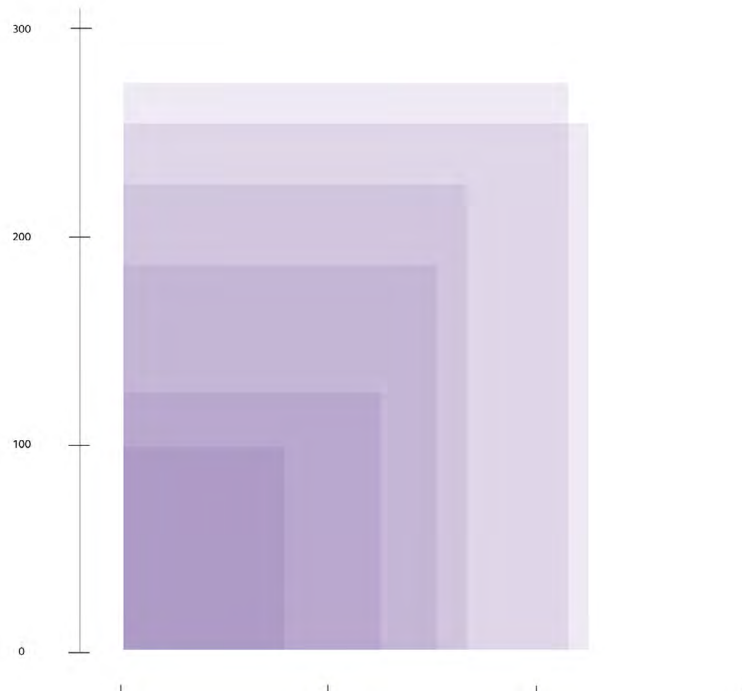
Paediatric mode



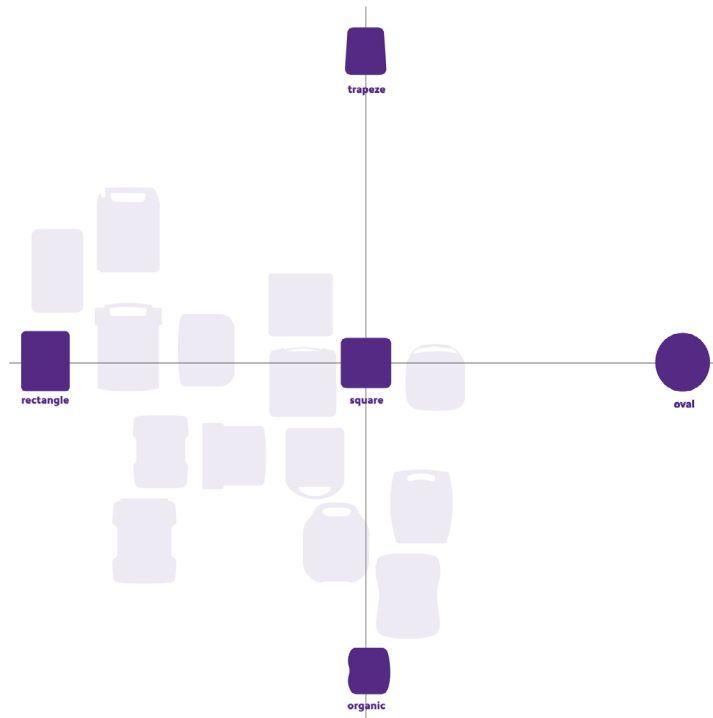
AED Size



AED Size / Generic AEDs



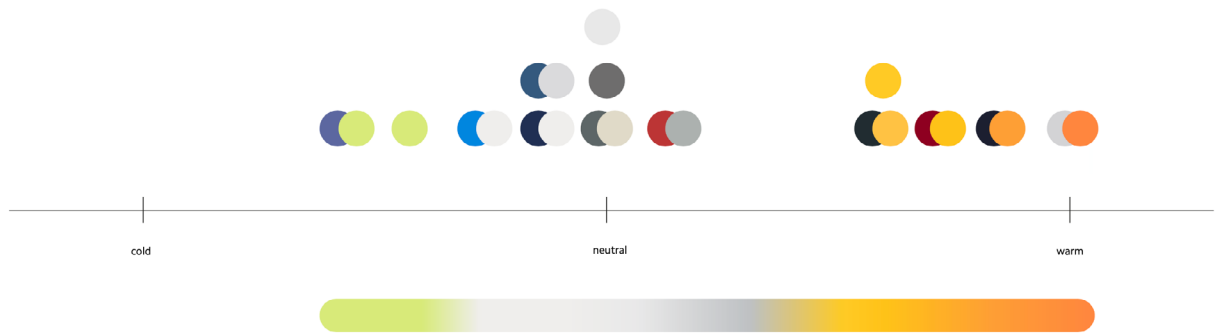
AED shape



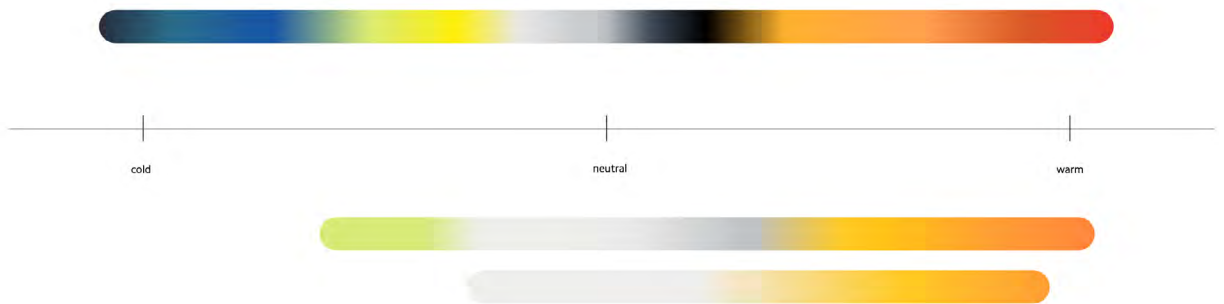
Colour scale



Colour scale



Colours scale comparison



Pads Photos



Pads Sensors



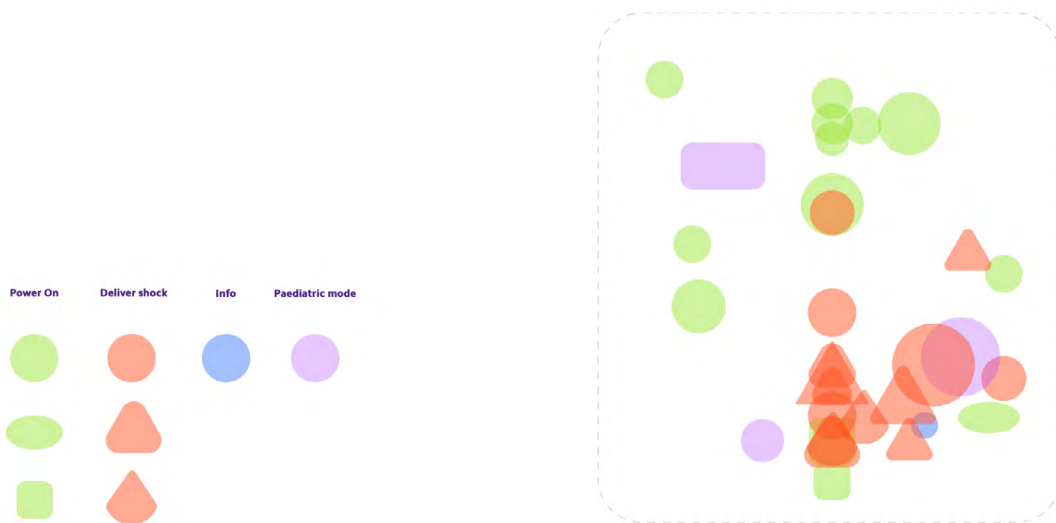
Proximity sensor

Capacitive sensor

Pads' shape



Buttons placement



Remote control



Batteries



2 x AA battery



3 x AA battery



4 x AA battery



6 x AA battery



8 x AA battery



6 x C-cell battery



3 x D-cell battery



4 x D-cell battery



Rechargeable lithium battery
(DC 3.7V / Li-ion Battery 4000mAh)

Additional teaching devices / Apps

Tablet

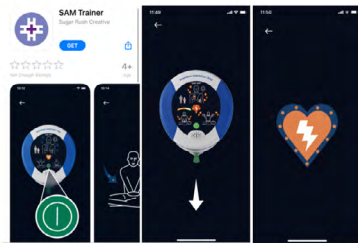


AED Trainer
by Medgadget

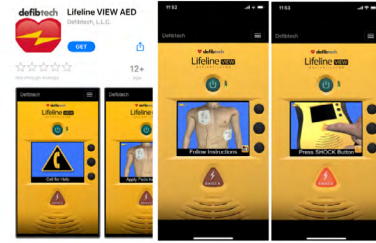


TabletAED
by Doczero

Phone

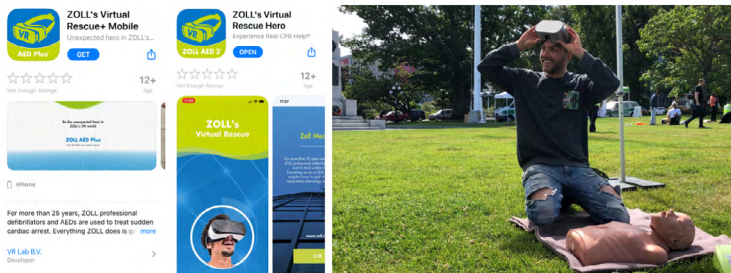


SAM Trainer
by Stryker

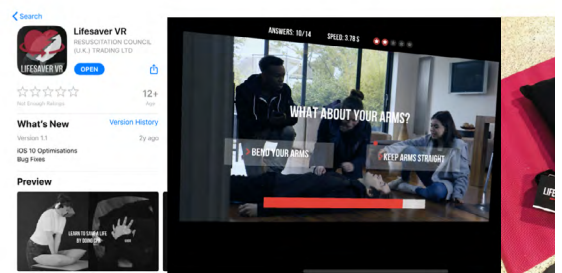


Lifeline View AED
by Defibtech

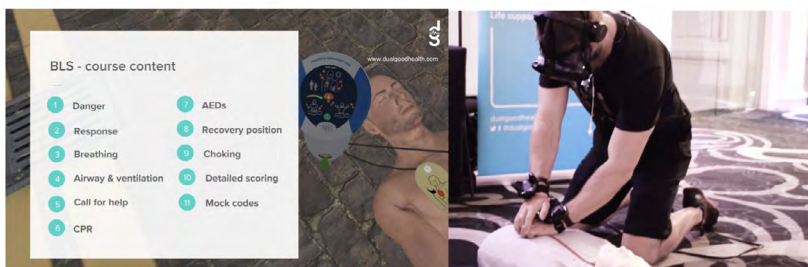
Additional teaching devices VR



ZOLL AED 3™
VR Hero app



Lifesaver VR
Resuscitation Council U.K.



BLS VR Training
by DuolingoHealth

D. QAED SYSTEM

Introduction

In order to integrate the QCPR with AED, the system has to recognise the presence of the AED (beginning of the interaction with AED) and the ID of the AED device. This information is used to calculate the CPR score, which is not affected by the correct operation of AED, but also recognises the delays in CPR which are the reason of incorrect operation of AED (teamwork, not following the voice prompts).

Qualities to measure:

Pad placement:

Pads have to be placed in the correct location: victims upper right and lower left. The assessment of correct pads placement is done based on the area, not a single point. The surface should have 30-45 mm in each direction from the centre of the correct position.

Reversing of the pads is not recommended with the AEDs produced between 1990-2005. They could have monophasic pads which are not interchangeable with regards to placement. However, the newer devices have biphasic pads which are interchangeable. This information could be address at the course but due to the low chances of interaction with the older device and extensive material of the first aid course, it is not necessary to include it as the requirement. Overall, correct pad position with the possibility to reverse pads is the only quality which has to me asses bu the system.

Delays in CPR:

Delays in CPR indicate both the skill to continue CPR when AED arrives and is being attached but also to follow the voice prompts (provide/continue CPR or stay clear).

Type of delays:

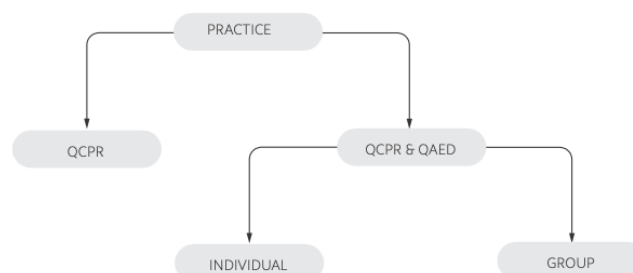
- 0-3 s (small delay) As the participants aim for the skills and confidence that small delay is not included in the scoring system
- 3-5 s (medium delay) It is a time frame which is necessary to provide the ventilation. Depending on the recognition of the airflow in the mannequin lungs system qualifies it as the mistake or not.
- >5 s (big delay) When a delay exceeds the 5 s it can indicate the use of AED or the mistake. The system has to check the confusions and evaluate the results.

Delays can occur:

- Before AED arrives
- When AED arrives
- When pads are being attached
- When AED recommends to provide/continue CPR

Process / First steps

As a first step, an instructor has to turn on the QAED mode so the QCPR system can recognise the possibility of the AED presence. Secondly, there are two scenarios in which the logic of the QCPR & AED has to be different. First one is the individual practice, and the second one is a group practice. To choose the correct settings of the system, the instructor has to select the correct mode in the app.



Individual practice (one participant)

When only one person is practising, CPR and AED cannot be performed at the same time. CPR has to be stopped to use AED. In this scenario, the only delay in CPR which is recognised as a mistake is the one which takes place when AED is connected to the mannequin with pads, and the voice prompts say to provide/continue CPR. In this scenario, the mannequin has to identify the AED when pads are connected.

Group practice (more than one participant)

Group practice can include from two to three participants. Each of them has a different task and complement each other in providing first aid. One participant provides CPR, second operates AED and the third one can provide ventilation or switch with the CPR provider after a while. Overall, the possibility to divide tasks enables the simultaneous use of AED and CPR, those the conditions of delays are more strict than in individual practice. In this scenario, the mannequin has to identify the AED when it arrives to the station.

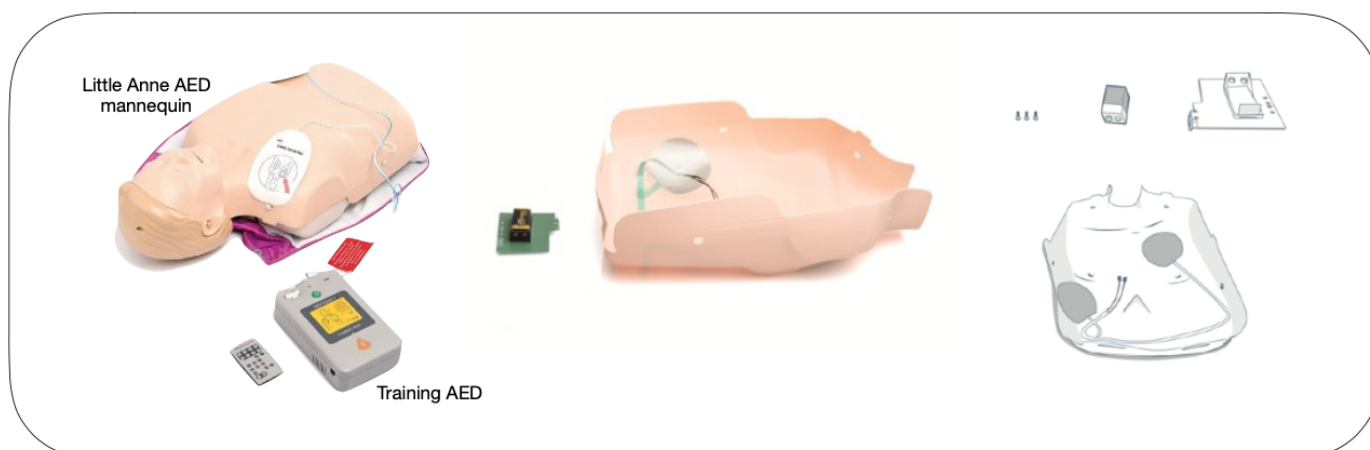
1. Current QCPR (Quality CPR) & AED system:

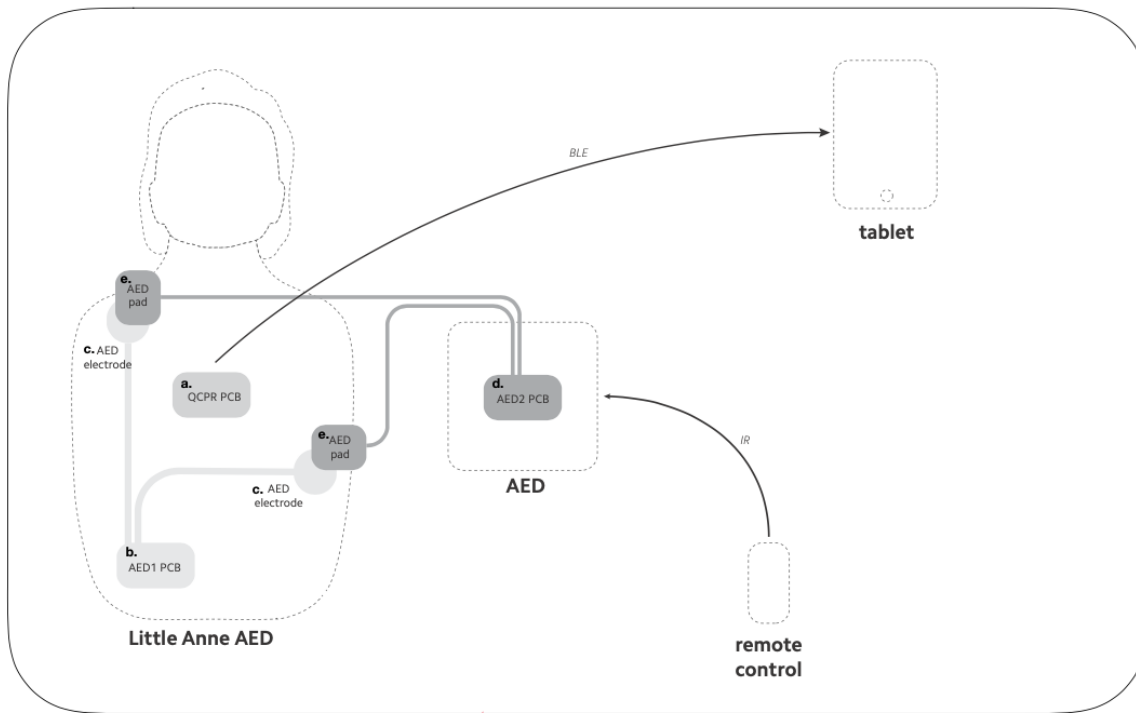
QCPR is a Quality CPR system

It provides real-time CPR feedback, intelligent scoring and guidelines and gaming elements with QCPR race competition. It consists of the mannequin, QCPR kit and a feedback device. QCPR kit can be integrated with the mannequin (Little Anne QCPR), or it could be added to the older mannequins (QCPR upgrade kit). QCPR sensor measure compression rate and depth, but also ventilation rate and amount. The feedback can be provided by a mobile device with the use of one of the app: QCPR Classroom, QCPR Instructor, QCPR Learner or by a Skill Guide device.

AED system

Laerdal has two AED systems. They both consist of the mannequin and Laerdal's AED device (Trainer 2 or Trainer 3). The aim of the product is to assess the correct pad placement and allow the audio sequence (voice prompts) to continue. The first system, Little Anne AED Training System consist of two capacitive sensors under a skin, PCB and a battery. The second system uses the metal stripe, which is placed on the mannequin instead of the sensors. Unfortunately, metal stripe is not a realistic solution. It indicates participants where to place pads. The AED devices have two types of training pads: regular ones and Link Technology pads which allows two-way communication between AED and capacitive sensors inside the mannequin. For the purpose of the study, Little Anne AED Training System with Link Technology pads will be analysed as the most advanced products from the company portfolio.

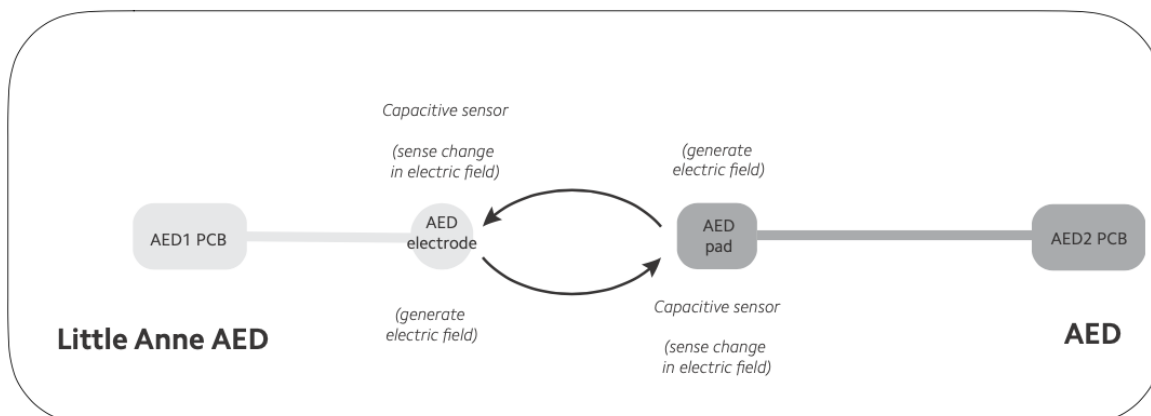




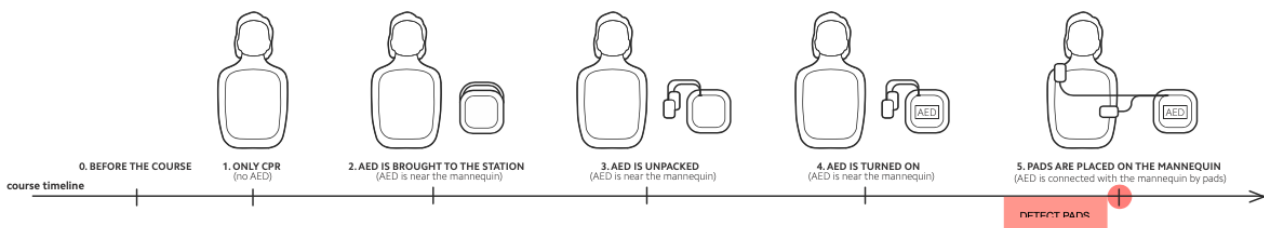
List of components:

- Little Anne AED (mannequin):
 - a. Q CPR PCB with BLE module and battery
 - b. AED1 PCB with battery
 - c. AED electrodes (connected with a capacitive sensor)
- AED:
 - d. AED2 PCB with battery
 - e. AED pads (connected with a capacitive sensor)
- Mobile device e.g tablet (Q CPR Classroom app)
- AED remote control

ASSESSMENT OF THE CORRECT PADS PLACEMENT



Course timeline:



Advantages:

- Provides feedback for assessment of correct pad placement.
- Capacitive sensor can precisely detect that pads are attached to the mannequin (low probability of error with a distance)

Disadvantages:

- QCPR system cannot be used during AED training. The use of AED negatively affects the results of CPR. QCPR system does not recognise the use of AED and identify it as an incorrect performance.
- There is no communication between AED and feedback device, which results in a lack of data about the participant's performance. As the data is not recorded, there is no feedback and guidelines.
- Capacitive sensor requires too high precision for placing pads. As a result, error can occur which will not happen in a real scenario. It puts the pressure on the participants to be perfect, instead of building the confidence when the pads are placed correctly. Solving the accuracy problem will require to increase the size on the pad which cannot be done.

Conclusion:

To provide feedback about the CPR and AED use, the current system has to be improved. Firstly, it has to enable the use of QCPR and AED at the same time. Secondly, it is important to provide the connection between the AED with the mobile device to collect and analyse data about participants performance. Also, the sensor used for the assessment of correct pad placement has to create a realistic scenario. To do it, it has to allow to detect pads on the bigger surface than the capacitive sensor.

2. Concepts of QAED system:

Design implications:

Requirements:

- Provide feedback for assessment of correct pads placement (correct, incorrect)
- Data from AEDs should be collected by a mobile device, analysed and presented in the form of feedback for each pair of devices (BLE connection with the mobile device)
- The system can recognise the delays in CPR after pads are attached (following voice prompts). To do it, the AED needs to have an ID number which can be read by the mannequin in order to combine the CPR and AED data.
- Participants are not required to do any additional steps which are not a part of the CPR&AED training
- No changes in the QCPR PCB
- Do not increase the size of the pads

Wishes:

- Live feedback for the instructor and participants
- QCPR system recognise the presence of AED and does not mark it as incorrect delay in CPR. Enable the use of AED with QCPR to provide the completed training scenario and assessment system
- Assessment of correct pad placement has a margin of mistake between 30-45 mm in each direction.
- Minimal number of additional activities to set up the equipment for instructor and participants
- Low cost of AED pads

List of concepts:

Based on the list of requirements and wishes, the following concepts were created:

BLE & inductive sensor

- Concept 1 / Automatic connection
- Concept 2 / Manual pairing

NFC

- Concept 4 / Paired with the second use

2.1 BLE & Inductive sensor

The BLE was selected as the most promising technology of detecting the presence of AED without the physical contact between the objects. However, it has low accuracy when the density of the devices is high. As a result, it can lead to the error in a dynamic environment of the AED course. Two concepts were created with the use of that technology.

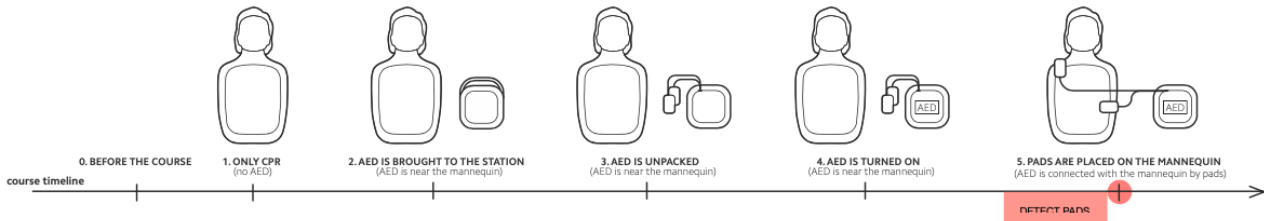
- Detect the presence of the AED and the ID of the AED device

The second PCB with the BLE module will be added to the mannequin. It will detect the presence and ID of AED by the use of BLE technology. The mannequin estimates the distance to the AED by measuring the strength of the signal (RSSI) from the AED. The closest AED devices will be paired with the mannequin. The arrival of AED (unpacking and turning it on) is expected to occur within 1,5 m and the use of AED will always be in the range of the mannequin due to the length of the pad's cable 1m.

- Assessment of correct pad placement

The mannequin will detect the correct placement of the pads by the use of inductive sensor under the skin of the mannequin and aluminium foil integrated into the pads.

Course timeline:



Advantages:

- Provides feedback for assessment of correct pad placement.
- Capacitive sensor can precisely detect that pads are attached to the mannequin (low probability of error with a distance)

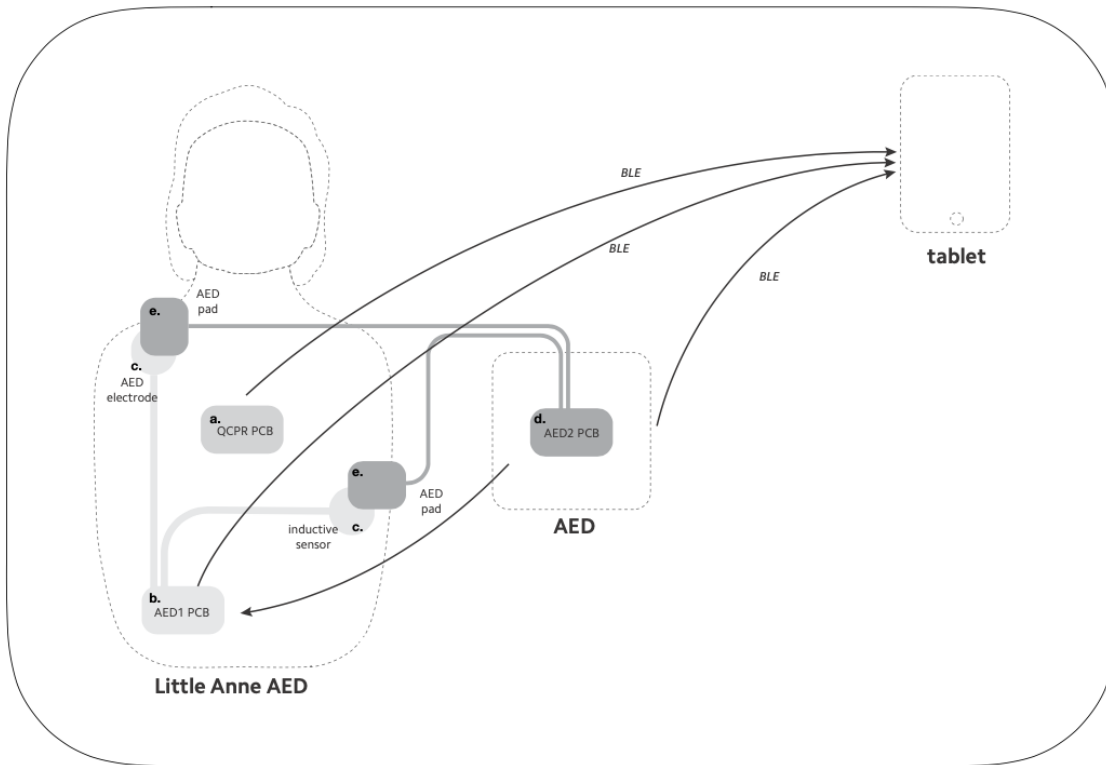
Disadvantages:

- QCPR system cannot be used during AED training. The use of AED negatively affects the results of CPR. QCPR system does not recognise the use of AED and identify it as an incorrect performance.
- There is no communication between AED and feedback device, which results in a lack of data about the participant's performance. As the data is not recorded, there is no feedback and guidelines.
- Capacitive sensor requires too high precision for placing pads. As a result, error can occur which will not happen in a real scenario. It puts the pressure on the participants to be perfect, instead of building the confidence when the pads are placed correctly. Solving the accuracy problem will require to increase the size on the pad which cannot be done.

Conclusion:

To provide feedback about the CPR and AED use, the current system has to be improved. Firstly, it has to enable the use of QCPR and AED at the same time. Secondly, it is important to provide the connection between the AED with the mobile device to collect and analyse data about participants performance. Also, the sensor used for the assessment of correct pad placement has to create a realistic scenario. To do it, it has to allow to detect pads on the bigger surface than the capacitive sensor.

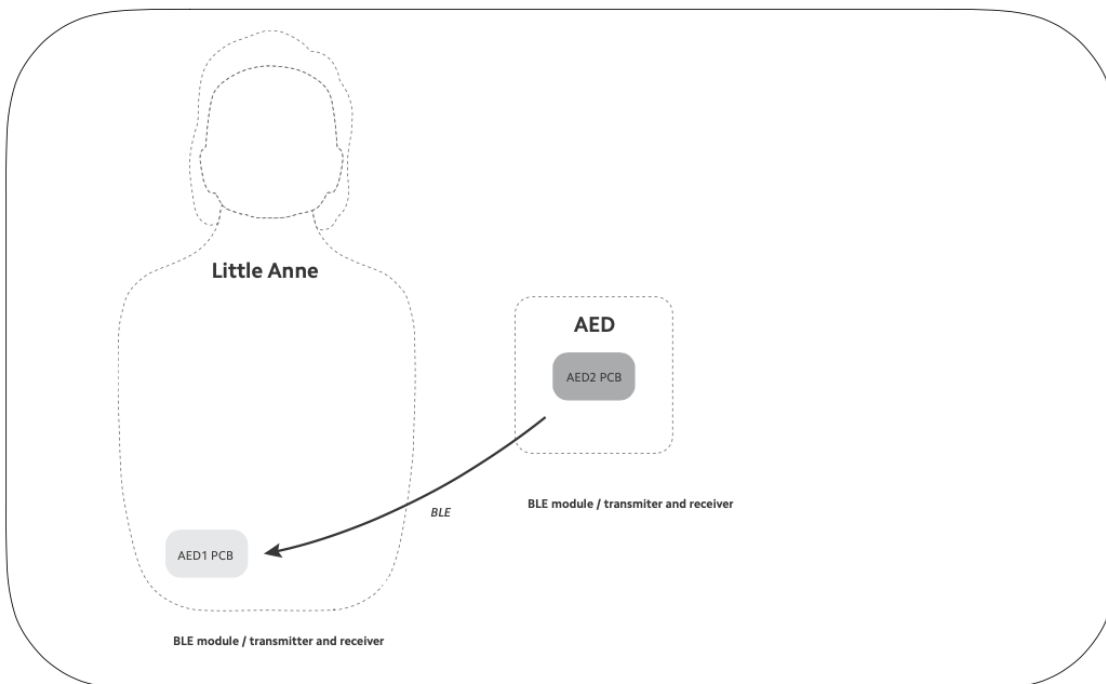
SYSTEM OVERVIEW



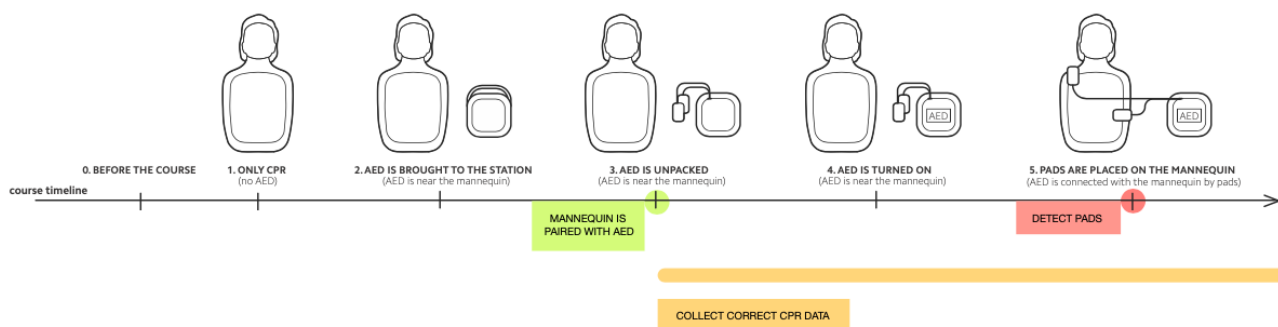
List of components:

- Little Anne AED:
 - a. Q CPR PCB with BLE module and battery
 - b. AED1 PCB with **BLE module** and battery
 - c. AED electrodes with **inductive sensor**
- AED:
 - d. AED2 PCB with **BLE module** and battery
 - e. AED pads (integrated with aluminium foil)
- Mobile device, e.g. tablet (Q CPR apps)

DETECT THE PRESENCE AND ID NUMBER OF AED



Concept 1 / Automatic connection



When AED devices are located in distance equal or bigger than 1,5 m from each other.

When AED is provided to the group of participants it is in the sleep mode. BLE module signal can be activated by unpacking the AED from the case or by turning the AED on by pressing a button. The mannequin will detect beacons in the range of 1m and choose the closest one and pair with it. It will not require any additional steps from instructor or participants. Also, there is no constraints which AED is provided to the participants.

Nevertheless, there is a possibility of two types of error. The first error can occur when the AED devices are unpacked/turned on prior to the placement next to the mannequin. The second one can happen when the AED was closer to the different mannequin than the AED, which was assigned to. Both mistakes will result in a lack of data about pad placement. In order to provide the data necessary for the AED to operate when the error occurs, the inductive sensor can be placed in the pads. However, it increases the cost of the pads.

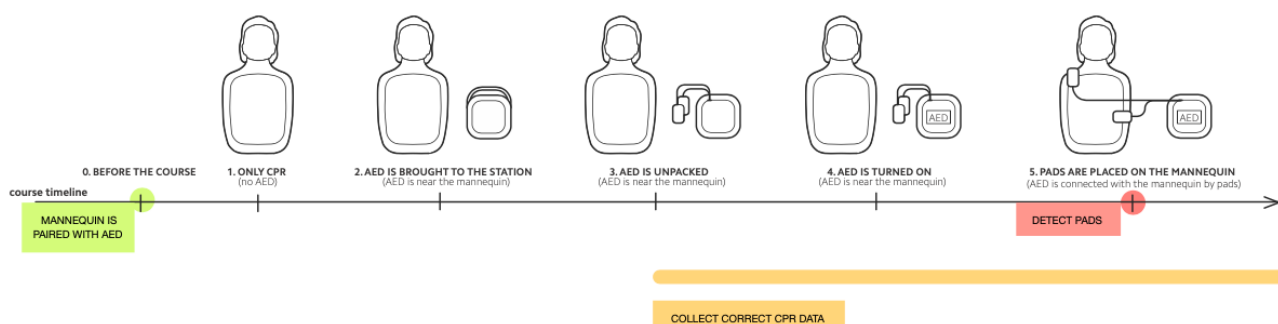
Advantages:

- Live feedback
- Feedback with the first use
- Provides feedback for assessment of correct pad placement
- A mobile device can collect data from AEDs and Little Annes, analysed and presented in the form of feedback for each pair of devices (AED+Little Anne)
- QCPR scoring system recognises the presence of AED. Enable the use of AED with QCPR to provide the completed training scenario and assessment system
- Low cost of the pads
- Participants are not required to do any additional steps which are not a part of the CPR&AED training

Disadvantages:

- If the density of the devices is high (the second device is in the range of 1m from the mannequin) the error can occur. To avoid it the devices can be paired manually for that scenario.
- Low precision of the inductive sensor. It can detect a pad before it is placed on the mannequin. However, the additional measures can be taken to minimise it.

Concept 2 / Manual pairing



When AED devices are located in distance smaller than 1,5 m from each other.

Securing the system requires additional steps prior to the exercise. Each mannequin has to be paired with AED. Also, that information about the pairs has to be easily accessible when the AED is provided to the participants. It has to be both on the mannequin but also on the AED case. There is a possibility of error if the instructor will provide the group of participants with the incorrect AED which was paired with a different mannequin. Pairing can be done by putting the AED near the chosen mannequin and locking the pair in the system.

Advantages:

- Live feedback
- Feedback with the first use
- Provides feedback for assessment of correct pad placement
- A mobile device can collect data from AEDs and Little Annes, analysed and presented in the form of feedback for each pair of devices (AED+Little Anne)
- QCPR scoring system recognise the presence of AED. Enable the use of AED with QCPR to provide the completed training scenario and assessment system
- Low cost of the pads
- Participants are not required to do any additional steps which are not a part of the CPR&AED training

Disadvantages:

- Requires to pair the devices manually. It can cause a distraction to the instructor work (before and during a course)
- Requires an additional indicators on AED, case and mannequin to recognise the pair
- Requires to check and choose correct AED for each mannequin based on the tag. It is an additional task for instructor or participants
- There is a possibility of an error if indication was read incorrectly
- Low precision of the inductive sensor. It can detect a pad before it is placed on the mannequin. However the additional measures can be taken to minimise it.

2.3 NFC

The NFC is precise and secure method of pairing the AED with the mannequin. However, it requires small distance between a tag and a reader. As a result this technology can only be integrated at the sage of attaching pads. This late recognition of AED in the scenario can affect the QCPR score and doesn't allow to integrate the systems in a complete way. Two concept were created to minimise the disadvantages and achieve the most reliable feedback.

NFC tag is placed under the skin and the NFC reader is it the pads (the NFC reader antenna is placed in the pads and the PCB is in the AED)

- Detect the presence of the AED (AED ID)

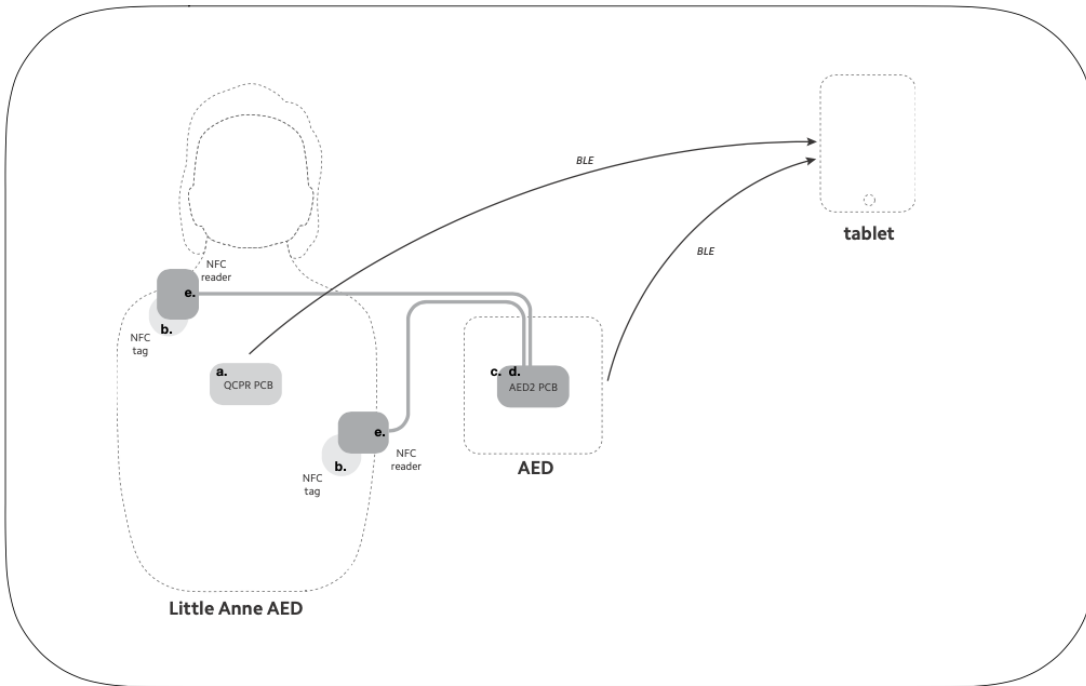
The mannequin will detect the presence and ID of AED when pads will be placed correctly on the mannequin.

- Assessment of correct pad placement

The mannequin will detect the correct placement of the pads by the use of the NFC tag under the skin of the mannequin and NFC reader integrated into the pad

The system can also work with the reverse position of the components. However, due to the disadvantages for the pairing the tag with the AED when pads are replaced only this concept was selected.

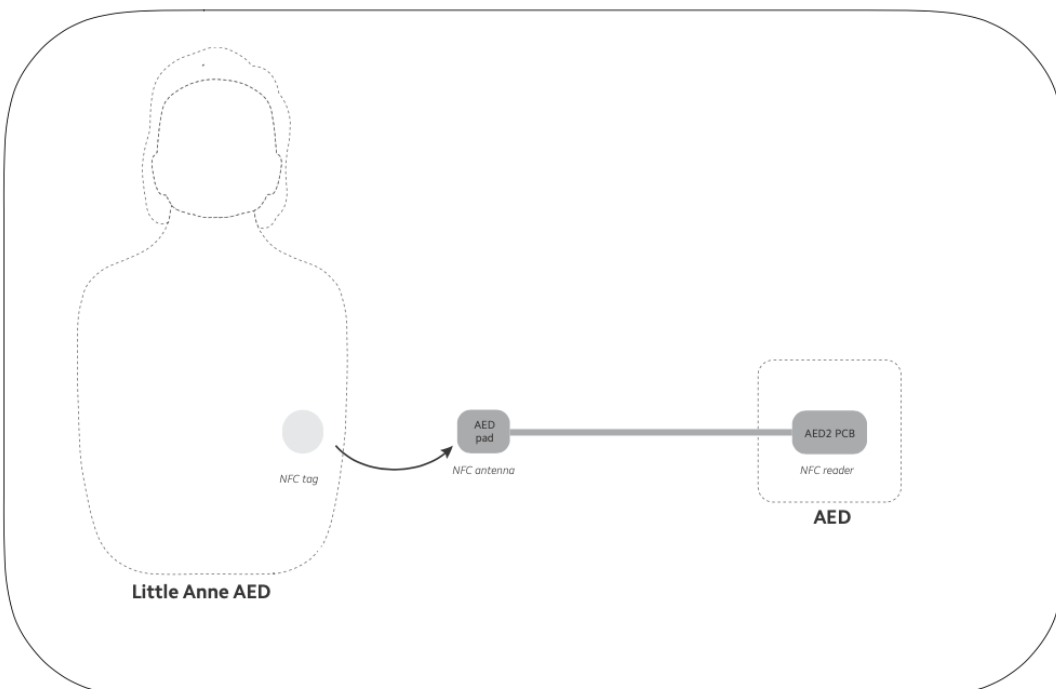
SYSTEM OVERVIEW



List of components:

- Little Anne AED:
 - a. QCPR PCB with BLE module and battery
 - b. NFC tag
- AED:
 - c. AED2 PCB with BLE module, battery
 - d. NFC reader
 - e. NFC antenna integrated with pads
- Mobile device, e.g. tablet (QCPR Classroom app)

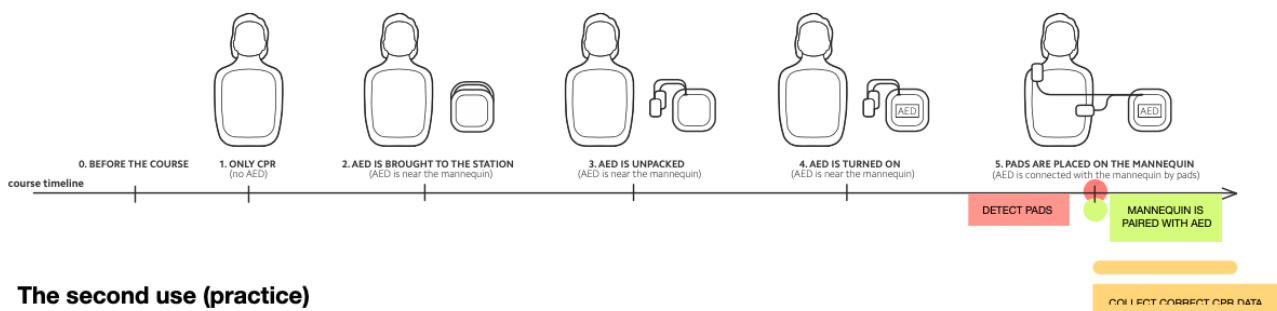
ASSESSMENT OF THE CORRECT PADS PLACEMENT AND DETECT THE ID OF AED DEVICE



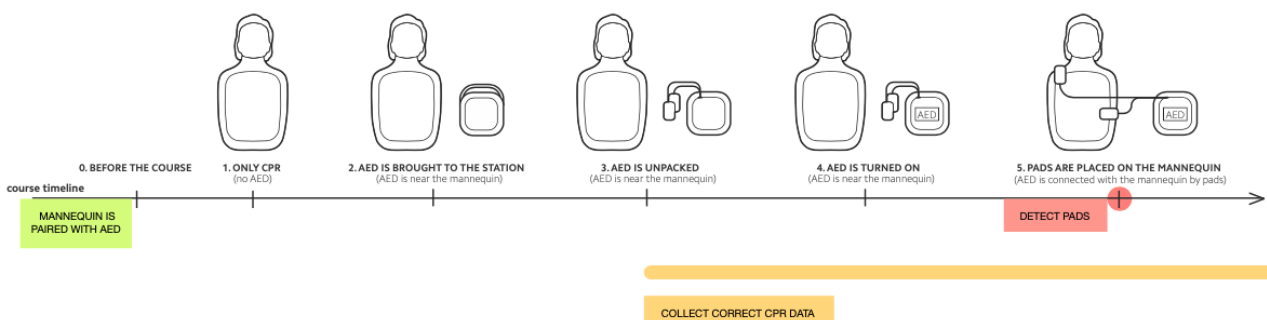
Concept 3 / Paired with the second use

This concept requires the first use with the selected devices to pair them. When AED pads are attached, reader under the skin recognise the NFC tag and pair devices together. However, the recognition takes place late in the scenario. The first results don't integrate the CPR performance before the pads are attached. With the second use devices are already paired and the data can be combined to calculate the correct CPR performance. Nevertheless, the system has one requirement, which is to use the same device with the same mannequin. If devices are changed, it should be communicated with the system (reset the pairs), and participants will receive only partial feedback.

The first use (e.g. guided by the instructor or exploration)



The second use (practice)



Advantages:

- Provides feedback for assessment of correct pad placement
- A mobile device can collect data from AEDs, analyse and present in the form of feedback
- NFC reader can precisely identify the ID of the AED device
- QCPR scoring system recognises the presence of AED with the second use. Enable the use of AED with QCPR to provide the completed training scenario and assessment system
- Participants are not required to do any additional steps which are not a part of the CPR&AED training
- It has less components than current system and BLE concepts. Second PCB in the mannequin is not required anymore. As a result is less complex and cheaper.

Disadvantages:

- Live feedback with the second use
- CPR feedback with the second use
- Requires to use the same AED device for each mannequin to achieve correct CPR feedback
- There is a possibility of an error if different AED was used, and it was not communicated to the system. The system can sense the mistake when pads are attached. It will result in incorrect live feedback, but the overall score after the exercise will be correct.

E. Final concept evaluation with instructors

AED

1. Can you easily recognise the functions of the buttons?

POWER ON/OFF & SHOCK

“Yes, definitely”

“Yes, they are easy to understand”

PAEDIATRIC MODE

“I can’t on the screen see the middle button very well. I can see the top one is obviously the power button, the bottom orange triangle is obviously the shock button. Is there a face on the middle one?”

“Is the middle one to analyse the rhythm? Oh yes, it is a baby face. Also the white icon on the white button doesn’t stand out very clearly.”

“The middle button I’m assuming that it is a child face, so when you press it it provides the defibrillation for a child. Am I right?”

“The middle one, I would be a little unsure if it is a child or a language changer”

INTERACTION

“Would the shock button light up or flash when it is ready to discharge? That would be lovely”

- The functions of the power and shock buttons were easily recognised due to the shape, colour and icons
- The child icon which represent the paediatric mode was unclear to the instructors and should be improved
- Contrast on the middle button was low and made it difficult to read the icon
- Instructor underlined the importance of the use of flashing lights with the shock button

2. What do you think about the arrangement of the buttons?

“I think that it is great”

“It is where they are often placed on the life models”

“The arrangement is nice, clear, simple, and the shape of them makes them very easy to differentiate. You are not going to push the wrong button by mistake”

-The arrangement of the buttons was assessed as correct

3. What is your opinion about the use of a display in the AED device to provide visual quotes to the voice prompts?

“That is making it more realistic obviously. We have people that come to the duty training and working in a noisy environment so may not recognise the voice prompt clearly. The screen’s text message support what the voice prompts is saying so it is suitable for everybody in that environment. I think that trainers has to adopt the similar approach and make a training a little bit more realistic and life like”

“Also most of them tend to just say place pads on the bare upper chest. It doesn’t specify which side of the chest. So being the picture, they got a very clear reference in orientation into the casualty”

“A lot of them (AEDs) have the picture on the pads and they tend to not look at the pads. They are too busy trying to peel the packing off”

- The use of display and visual cues was assessed positively.
- The argument were:
 - Helps to understand the voice prompts in the sound enrolment of the training
 - Similarity to the life models
 - Helps to understand where to place pads

4. What do you think about the positioning of the pads? (advantages, disadvantages)

“I think that it works really well”

“Yes it works well. Definitely”

“It stores them nice and neatly. From a training perspective everything is nice and compact. It makes it easy to carry around and use”

“I don’t see any disadvantages of this positioning of the pads in the AED device”

“It is hard to assess without actually training it, but it looks like the good position for me”

“It has several advantages. It is going to protect the pads, make their working life longer, they are easy to see, they are not going to tangle up in the cable get all mangled which happens quite frequently and it is a nice compact safe storage”

- Position of the pads was evaluated as nice and compact
- It was mentioned that it could facilitate the safety of the pads and cables
- No disadvantages were recognised, however interaction with the physical device is needed to evaluate it correctly

5. Do you think that pads should be preconnected or they should be detached from the AED?

“Pads should be preconnected”

“I agree that pads should be pre connected. Most of the AED I work with that are pre connected so they are used to the idea that they are already plugged in”

“The advantage is that the connector is not pulled in and out constantly which potentially damages some”

“Some AEDs have this facility some don’t. So basically, like I said to produce the generic AED trainer so to me the pads should be attached”

“For me it is fine to have them attached. Because as a trainer you say: you might need to plug them in on some models and I think that it is enough”

“For the protection of the connector and the cable folding over the device it is going to be very easy for that cable to become damaged in transportation, so possibly just to plug it in as you use it”

put the cable in the risk

5.1. Pads

“It is excellent that the pads will be recognised if they are in the correct position”

“Good”

- Feature of recognising the correct and incorrect position of pads was evaluated as positive and beneficial for a training
- Some concerns were raised about the price of the pads and if maintained will add more work to instructors

6. It looks like AED training device.

7 / 7 / 6 = 6,7

7 “It is quite generic and I feel like I can use it on any AED course not restricted by any models that the client has”

“The colouring, shape, markings, the buttons, the screen and it is obviously it is an AED trainer text on top of it as well.”

7 “It definitely looks like an AED trainer”

“I would give 6. It is because the colour. Maybe if it would be possible to make it, the actual casing the more dynamic colour, so it is obvious that red. A lot of AEDs are brightly coloured. And it could be confused with some form of hand held device”

- QAED trainer appearance was described as representative for the generic training devices.
- One instructor brought a concern about the colours which are less bright than AED devices.

7. The appearance is familiar with AED.

7 / 7 / 3 = 5,7

“From my point of view, there is lots of AED on the market. All with different specifications and they are all like cars. But in the end of the day that are all driven in the same way. So this AED trainer it could be used to train AED on every course respectfully to what model the customer would like”

“I would disagree. I prefer your presentation of the AED. It is simple, compact. There is less to get wrong, less to get messy about with. It is going to be very easy to get going very quickly. But I think that participants will get the similarity to the AED devices”

- Two instructors evaluated the appearance as highly familiar to the AED.
- One instructor disagreed with that statement by giving the low score. The reasons were the more simple and compact appearance compared to the AEDs on the market. However, those differences were described as advantages for the training purpose. Also, the instructor said that participants will still understand the similarity between those two types of devices.

like AED”

“It feels like AED”

“Because of the pads being plugged in and that cable becoming damaged. And I would be concern about the screen being scratched and marked being marked, but in general it is very practical”

“They are not always as careful with the equipment as you would like, so the silicon case is definitely a bonus”

“Being able to charge the device is definitely a benefit. And the battery status so know before you leave your venue that it is completely charged or you get the chance to take it home and bring it charged ready for a next day. So you are not caught with an item that needs a new battery but you haven’t got the batteries with you”

“If you have to take the Add to the course that is being held in the company, you get half way through and suddenly the battery go. And If you haven’t backed before the spare batteries you then completely lost”

- Based on the visuals and concept description it was described as practical. The explanation included the similarity of the device in appearance and function to the AED devices. Additional case and battery charging and indicator were positively appreciated.
- One instructor brought a concern about the possibility to damage the cable or scratched the
- It was mentioned that this characteristic is difficult to asses fully without the physical device

9. Traditional vs Innovative

5 / 5 / 7 = 5,7

“I think that you made it for quite range market. Laerdal produce the number of defibrillators and I understand that that’s the market you are aiming for but what you got here is a unit that can be used on every AED course.”

“It is somewhere in the middle. Cause it is clearly recognisable as the AED machine but it looks slightly more refreshed”

“It is easy to transport, it is simple, it is sensible and it is not confusing”

- QAED trainer appearance was evaluated as in between traditional and innovative and it was seeded as an advantage. The appearance represents AED so it can be used at every course but it looks refreshed and is adjusted for a training.

10. Unprofessional vs professional

7 / 6 / 6 = 6,3

“It is hard to tell without seeing one live but based on the picture it looks professional”

“If it would be just sth to have along the lines of the branding what you mention earlier. Like having the case green for St John Ambulance but it is a lovely looking unit”

- Overall QAED trainer appearance was evaluated as professional.

6 / 6 / 6 = 6

“For me, looking on the pictures it looks like a good quality build AED trainer and most of the devices on the market are kind of fragile and cannot be dropped and ect. I like the idea of having the case and the silicone case around it as well. It gives a little extra protection”

“From the look it is considered, neat, compact. From appearances it looks like it has been designed to do exactly one job “

- All instructors said the QAED trainer appears as high quality device. It was described as neat, compact and robust thanks to the additional case.

11. Ugly vs Attractive

7 / 6 / 6 = 6,3

“It is attractive looking training model. It has a large screen, the buttons are defined and straight. I like the idea of pads underneath and the connector, the silicone case and the other astral case.”

“Great looking”

“Looks good”

“I don't think that any technology can be attractive so I will give it 6. It is neat, tidy, well presented, and it is uncomplicated. Nice smooth lines”

- All instructors described QAED trainer as attractive for the AED training device.

12. Would you like to use it during your courses?

“Yes, when can you send me one?”

“Yes, I think I would use it during the training to be honest.”

“Definitely for me”

“Yes, because of the size, it is much more practical size”

“I like it and I'm quite impressed to be fair. I would like to get the hands on one as soon as possible”

- All instructors expressed the willingness to use the QAED training device at their course. The size and simplicity of the device were the main advantages.

13. Do you see the future potential of the concept?

“Yes”

“I think that is gonna be a great resource to be used at the classroom. I like the idea of the rechargeable battery, battery power indicator, the design of it. The only issue from the organisation of it is the final cost of it. We have to buy hungriest and hungriest of them so in reality it is a great product but is the cost gonna be high/“

“Massive. Because it is transportable, it is not intimidating, it is not going to be a scary and complicated as a lot of learners think that AED is. It tells you by looking at it that using it is quick and is simple”

“The CPR icons are spot on, they tell you exactly what the problem is, they can see instantly what they are doing right or wrong. It is instant feedback”

“They are nice and clear. If you will use them in a QCPR app they marry quite nicely.”

“I think that it is a vital information. Whether the shock was delivered in a timely manner and whether the pads are in the correct placement and whether there was delay in the CPR being started. They are the key 3 things that we are looking for at a training session.”

“That’s absolutely fine. The colour choice is lovely because if you will go with red for mistakes you are highlighting the negative so here you are just simple indicating you are doing it but you can do it a bit better. And again in tells them exactly what is wrong. What part of it they need to practice. I like that a lot”

“Having only illustrate is just fine. It is enough, It tells exactly the symbols, icons. They are specific, detailed. They are telling you exactly what the problem is”

“It is quick, simple, easy to act on. If there is too much text involved your are going to become focused on text rather on method of the delegates. I like the icons”

- The icons proposed for the QAED performance qualities were described as coherent with the one used currently for the QCPR
- Instructors agreed that the chosen three qualities of the AED training are the most important to asses from their perspective
- Instructor evaluated icons positively. No recommendations were given for the improvement of their appearance.
- One instructor stated that icons are the most efficient communication tool during the training. Adding the text with the description or feedback suggestions would take instructors; attention form the students.

2. What do you think about the proposed scale?

“If people are used to use in the QCPR and there are 3 colours then it speak with what people already know”

“I try to stay away from figures like that (score). It is all about effectiveness.”

“Unfortunately, we have trainers who will demoralise and demotivate the learners: you got 70% and it is the crap. Rather then the definitive scoring metrics to have effective or not effective”

“I don’t know, cause I quite successfully use the QCPR with students and you can visibly see that they scores are dramatically improving really quickly because of the feedback they gave, what areas to work on. Although, some of the instructors were quite oh I’m not sure about seeing the score, actually the delegates we worked with they really liked it. So I can see the use for it but it got to be managed”

“The trainers got to be skilled how to deal with low figures and how to approach the learners”

“I think that having one feedback for CPR and one feedback for AED will be good”

“The red colour definitely helps, it makes you very aware that there is basic problem with group number 4. That someone in this group hasn’t understood what you told them because they are completely missing the whole point of the training. They are mixing the key part of the routine”

“I think that it is good that it is in the red. Because it it will tell you it during the training, it would then completely take your attention away from other groups And you will end up focusing only on the group with red and it is not fair because there is obviously some problem also with others. You have to give equal attention across all of them during the training and then correct the errors afterwards. Make them aware where the problem is and run the sessions again”

“If there is one big mistake like not delivering a shock there should be just one information. But if there was a combination of pad being in the wrong place and incorrect compression I think that both of them should come up at the same time”

- The scale should be consisted with the one used in other Laerdal apps
- For the live feedback all instructors agreed that 2 level scale with green and yellow suites best the training scenario. It was asses as simple and effective for having the overview of the class performance.
- For the final score, instructors were divided about the need of the 3 level scale (green, yellow, red). First instruct said that QCPR instructor app has 3 level scale so it should be the same to maintain the consistency. Second instructor stated that performance should be evaluated only as effective and not effective what would result in 2 level scale. However, the third instructor saw a significant advantage of having the strong information that someone didn't delivered a shock with the use of third colour.
- Also, in terms of the final score, instructors gave positive and negative effect of the use of numbers in the final scale on the training outcome. However, the conclusion was that instructor should be trained if and how to use the scores in communication with students

17. What do you think about the screen for participants/learners?

“That's the thing you see is producing negative feelings. If they get a low scores consistently and we can't see to improve that scores that it is going to be demotivating”

“If the learners don't see those scores and it is up to instructor to approach the learner and say that we need some more action or training to improve the skills without giving them the scores. I don't think that they need to know the score”

“I agree that they don't need to see the scores”

“I think that if everybody done really well you can share but I think that there are occasions that you would not share that”

“ I think that is is good idea but there are occasions when I will choose not to use it”

“Its gets to be done to the discretion of the trainer”

“I'm a believer that they did vey well - tell them that they did very well”

“I think that it would depend on the group whether show it our not. If there will be one group who failed to deliver a shockI would be reluctant to put it up on the screen. It would almost be humiliating, for the group to say that you forgot to deliver a shock. But if they will be good results I would put them on the screen because it highlights everybody the importance of ventilation, giving the right rate of compressions, the right depts of compressions. It helps them to correct now in the immediate feedback any problems that have been identified and then it gives you the option to say now with in that in mind you need to think about ... Lets go again and lets see if we

“The instructors need the information (red) to be able to correct their (participants) performance but again not the students, for the question of them feeling single doubt be little silly”

- Instructors stated that sharing a data about the class performance with students on the TV/ screen should be optional
- All instructors agreed that participants shouldn't see the red colour because it will have the negative effect on their confidence

17. Complicated vs simple

7 / 6 / 7 = 6,7

“I struggle with colours as I'm ocular blind”

“They are fine for me but I don't struggle with colours. Maybe getting them darker will improve it”

“The icons are clear, consist, they tell you exactly what the students have achieved and if there is a problem it very quickly and simply shows you what the problem are is”

- Overall, the interface was evaluated as simple and clear. However, one instructor pointed out that he is colour blinded and he struggles with reading between green and yellow icons.

18. Confusing vs Clear

7 / 7 / 7 = 7

19. Impractical vs practical

7 / 7 / 7 = 7

“Too much written text is time consuming, and the time it takes you to read the message on the screen you haven't got your attention on the students that they are actually doing the training. A quick look at that screen and you got the information you need in seconds”

- The interface was described as very practical. Aside from providing useful information about the students performance the advantage was the use of only icons which are easy and fast to read”

20. Overwhelming vs Plain

7 / 7 / 7 = 7

“You are using existing QCPR platform anyway”

“I think that it is plain in the positive way”

“Nice, clear, consist symbols that tell you exactly which part of the trainings the problem.

(It is very good information. It highlights areas of weakness which need to be focus on)

- The interface was rated as plain. Further discussion explained that plain was interpreted as a positive adjective which express the clear and consist design and there is no missing elements.

.....

“The icons are anatomically suited to the situation and it gives the overall message that we are considering the whole of the application of CPR and AED when not just simple focusing on one area”

- Instructors described the interface as professional. Integration of information about CPR and AED plus the appearance of the icons are the main advantages.

22. Ugly vs Attractive

7 / 7 / 7 = 7

“It is clear, consistent, easy to read, it is easy on the eye. It is not going to give you an eye ache if you will stare on that screen for any amount of time”

-Instructors described the interface as attractive because it is clear, consistent and nice to look at.

23. Do you see the future potential of this concept?

“Yes. That’s something that we cannot give feedback on. Having a visual look at what we think that would be the right depth of compression. With the right rate of compression we can actually help people find tune the CPR and the use of AED which is got to be beneficial for the casualties”

“I like that that there is still the feedback on CPR performance. That going to give the learners the confidence. Being able to give feedback on individual performances. You are doing it well, you are doing it right and also to pick up anyone in the group that has a slight problem that you are not identifying from trying to watch six or 8 people at the same time”

24. Additional comments

“I struggle with a colours. I’m colour blinded so I struggle with a colour. Green is my colour blind colour”

“I like the three levels of the training”

“Showing just one information or two information about the mistake? I’m not sure now because it is making me aware that you would be highlighting the negative. If you would concentrate on compression rate first, because it is the most important part. And then once they got that one right if the ventilation is not correct that can be tweak later. So address one problem and then the other. I think that you are right to show one at a time”

- In live feedback show one information at a time to make it easy and fast to read


F. Final concept evaluation with potential participants

Section 1 of 6

The Future of AED training

Form description

This research is part of the Master Thesis of student Anna Gębala for the faculty of Industrial Design Engineering at the TU Delft. The purpose of the study is to evaluate the concept of the interface for the AED (automated external defibrillator) training. The questionnaire is about the interface, and it takes 3 to 5 minutes to fill in.



Section 2 of 6

Basic information

Description (optional)

Sex *

Female

Male

Age *

20-30

30-40

40-50

50+

Experience with an AED training *

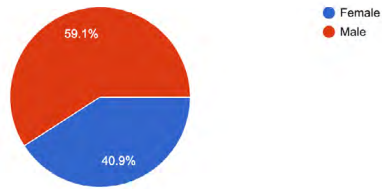
Yes

No

Basic information

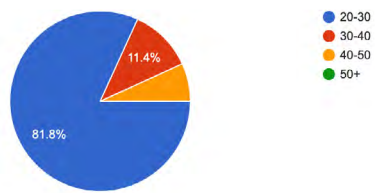
Sex

44 responses



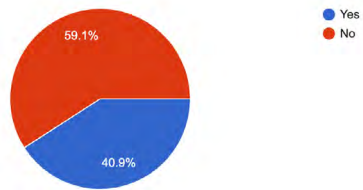
Age

44 responses



Experience with an AED training

44 responses



Introduction to the context



Description (optional)

Imagine that you are at the First Aid Training. In a group of two you have been practising first aid with CPR (cardiovascular resuscitation / heart massage) and the use of AED (automated external defibrillator). While you were exercising, the devices were measuring your performance.



The instructor has just told you that you have finished the exercise and that you can check your results on the TV screen.



