Empathize

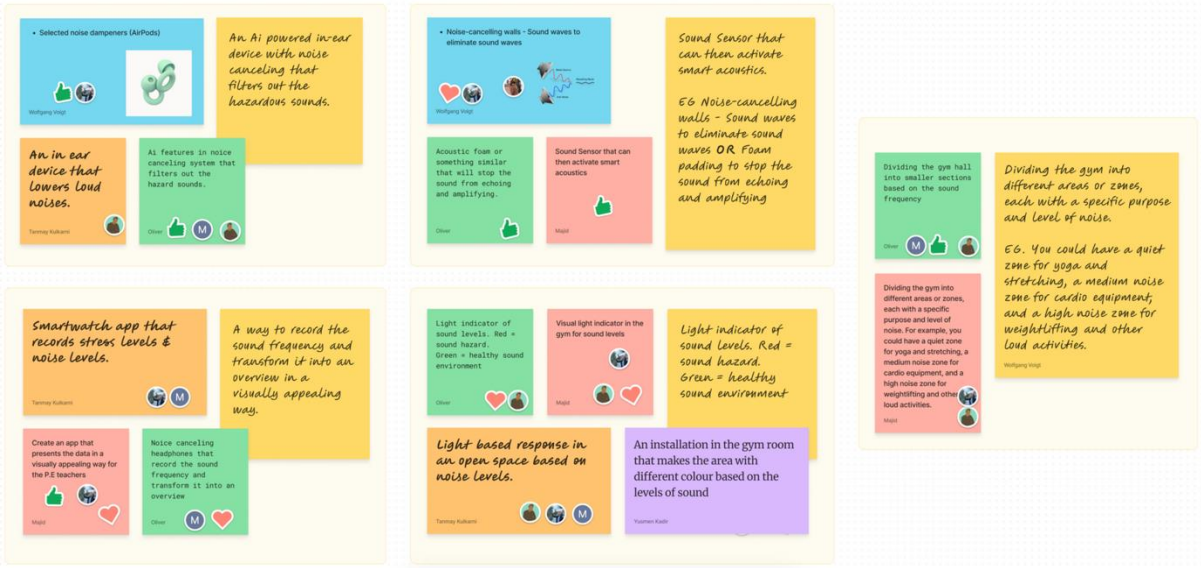
Brainstorm possible solutions

Question: How can physical education teachers in primary schools get more insights into the sound levels and stress during their classes?

Method: Ideation

Why: To generate and develop new ideas

How: Initially, we began by distributing sticky notes to each person, allowing them to write down their individual ideas. Subsequently, we conducted a voting process to identify the most intriguing concepts. Once we had selected the noteworthy ideas, we proceeded to group similar ones together, consolidating them into clusters and ultimately condensing them into five distinct ideas. (Figure 1)



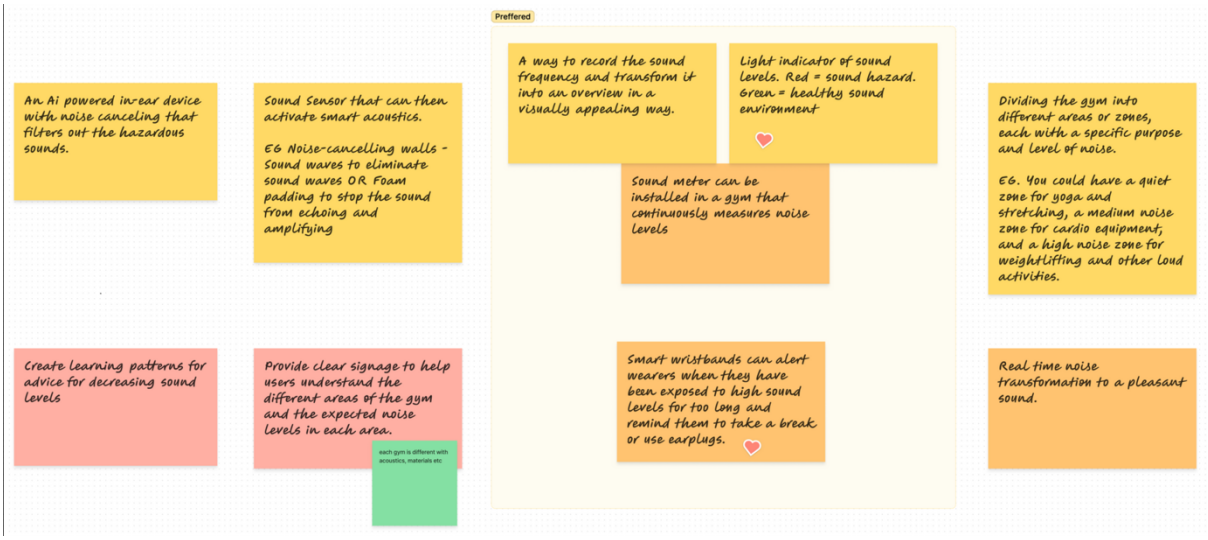
(Figure 1) Voted ideas.

Following that, we showcased our ideas to the key stakeholder of the project, gathering their valuable feedback on the options that resonated with them. Additionally, we proposed an idea that involved envisioning a cohesive ecosystem of interconnected solutions, which demonstrated its promise in the "Preferred" section, as evident from the results provided below.

Results:

- Implementing a light indicator to gauge sound levels, where the color red signifies a potential sound hazard and green indicates a healthy sound environment.

- Installing a sound meter within a gym setting to monitor and measure noise levels consistently.
- Introducing smart wristbands that notify wearers when they have been exposed to prolonged high sound levels, prompting them to take a break or utilize earplugs as a precautionary measure. (Figure 2)



(Figure 2) Results, summary

Conclusion and recommendation

In our brainstorming session, we came up with several potential solutions to address the issue of providing primary school physical education teachers with better insights into sound levels and stress during their classes. Among these ideas, one particularly interesting concept emerged: building an ecosystem of interconnected solutions, centered around a smartwatch app. By exploring various options, we gained a deeper understanding of the problem and discovered potential avenues for improvement. Subsequently, we received feedback that led us to the next phase.

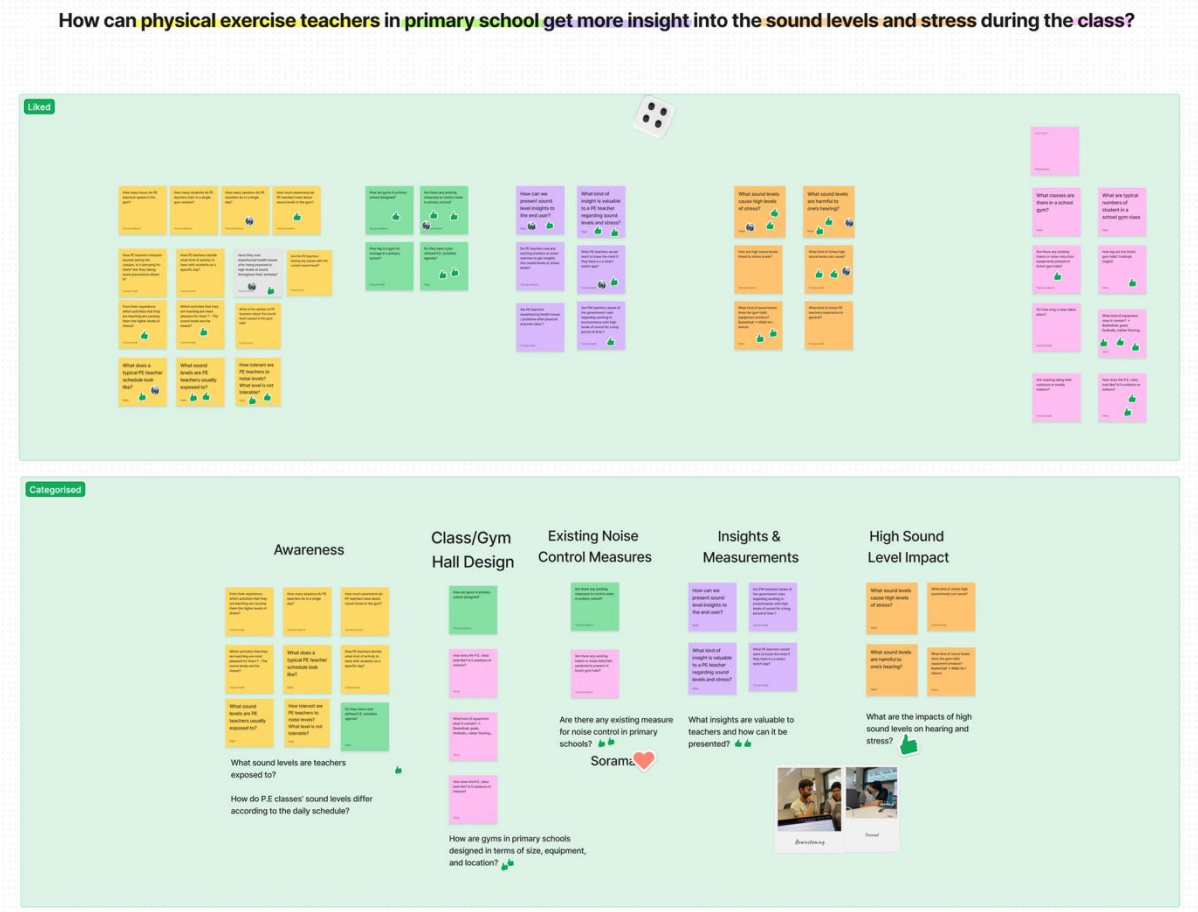
Brainstorm – research questions

Question: How can physical education teachers in primary schools get more insights into the sound levels and stress during their classes?

Method: Ideation

Why: To generate and develop new ideas

How: Each team member contributed their ideas for questions on individual sticky notes. Subsequently, we conducted a voting process to identify the most promising questions. Once the selection was made, we proceeded to group similar questions together and refined them to create one comprehensive question for each cluster. This process led us to formulate a main question and six sub-questions. (Figure 1)



(Figure 1) Questions

Results:

Sub - Questions	**ICT Research Methods**
What insights are valuable to teachers?	**(Field)** User interviews, **(Library)** Community Research, **(Field)** Surveys, **(Field)** Data analysis, **(Library)** Literature Study
How do P.E. classes' sound levels differ according to the daily schedule?	**(Field)** Data analysis, User interviews
How are gyms in primary schools designed in terms of size, equipment, and location?	**(Library)** Literature Study, **(Field)** User interviews
Are there any existing measures for noise control in primary schools?	**(Library)** Expert interview, **(Field)** Observation, **(Library)** Literature study
What are the short-term impacts of high sound levels on hearing and stress?	**(Library)** Literature study, **(Library)** Expert interview
What medium is best to present the visual solutions for the end users? - How can the principles of human factors and ergonomics be integrated to create products and services that are usable, safe, and comfortable for a diverse range of users?	**(Library)** Literature study, **(Library)** Community Research, **(Library)** SWOT Analysis, **(Lab)** A/B Testing, **(Lab)** Usability Testing
How can valuable insights be presented to the end users?	**(Library)** Competitor analysis, Best & Good practices, **(Lab)** A/B Testing,

Conclusion and recommendation:

The research questions played a vital role in steering our research process, as they provided us with a roadmap for obtaining the necessary information to devise a successful solution. By deconstructing the main question into sub-questions, we were able to pinpoint potential areas of opportunity and explore the problem from various angles. This step was pivotal in establishing a strong foundation for the project and ensuring that we had a solid base to build upon.

Literature study

Question: Are there any existing measures for noise control in primary schools?

Method: Literature Study

Why: As the researcher, this approach grants me the opportunity to delve into the realm of existing knowledge, acquire contextual information, seek guidance, and uncover best practices within my field. Consequently, I can enhance my understanding and effectively apply valuable insights to the group's research.

How: I began by exploring the question I was given and conducted thorough research on the internet to find relevant literature pertaining to that question. Although it proved challenging to locate the necessary information, I persevered and ultimately succeeded. Subsequently, I gathered and compiled the insights that I deemed valuable and intriguing within the context of the project.

Results:

Current measures:

1. Acoustic ceiling tiles - These tiles absorb sound and reduce echo in the classroom.
2. Carpets and rugs - These absorb sound and reduce noise levels in the classroom.
3. Acoustic panels - These are wall-mounted panels that absorb sound and reduce noise levels in the classroom.
4. Double glazing - Double glazing reduces the amount of noise that enters the classroom from outside.
5. Sound-absorbing curtains - These curtains absorb sound and reduce noise levels in the classroom.
6. Sound-absorbing furniture - Furniture with sound-absorbing properties can help reduce noise levels in the classroom.

(Article)

After the establishment of the main **IEQ** problem, namely noise, the next step of this research was searching for an effective way to address this problem. Because the use of individually controlled devices in offices has shown to be able to improve both the **IEQ** and the workers' satisfaction rates, **it was assumed that these devices can have a similar effect on children or teachers in classrooms.** To get a preliminary understanding of this assumption, a series of computer simulations was therefore conducted to test the effect of an individually controlled device on noise reduction. **By comparing the simulation results of these individually controlled devices with the conventional ways to reduce noise (namely acoustic ceiling tiles), it was seen that the individually controlled devices have the ability to provide better acoustics in terms of providing shorter RTs and higher speech transmission indices.**

Subsequently, **a real individually controlled noise-reducing device (ICND)** was prototyped and tested in a lab study during the summer and autumn vacation of **2019.** This prototype was similar to the stimulated device. **It looks like a large umbrella that hung above every child's head.** In this research, two identical prototypes were tested with more than 200 school children, whose feedback

was collected through questionnaires. Children could control the device using a remote controller. The descriptive analysis of children's answers indicated that most of them liked this device and wanted to have one in their classrooms.

Conclusion:

in conclusion, the research focused on addressing the problem of noise in classrooms, exploring various solutions such as acoustic ceiling tiles, carpets and rugs, acoustic panels, double glazing, sound-absorbing curtains, and sound-absorbing furniture. Computer simulations comparing individually controlled devices (ICDs) with conventional methods showed that ICDs provide better acoustics with shorter reverberation times and higher speech transmission indices. Subsequently, a physical prototype of an individually controlled noise-reducing device (ICND) resembling a large umbrella was tested with over 200 school children, who expressed a positive reception and a desire to have it in their classrooms. These findings highlight the potential of ICNDs to effectively address classroom noise and improve the learning environment for both children and teachers.

Expert interview

Question: How are gyms in primary schools designed in terms of size, equipment, and location?

Method: Document Analysis

Why: It facilitates a deeper understanding by engaging with an experienced professional who can offer valuable perspectives, knowledge, and recommendations aligned with the goals and objectives of the project.

How: Once we compiled the questions, we coordinated with our point of contact (POC) to secure an interview appointment. The interview was conducted by Majid, Wolf, and myself as a group.

Results:
The stakeholder interview revealed several significant points. The primary goal identified was the improvement of sports halls by requesting manufacturers to create holes in the walls, particularly in the main sound reflective areas, for the placement of sound absorption materials. The second goal, which relates to the Grip op Geluid project, involved exploring the possibility of developing soundscapes to analyze and characterize activities with varying noise levels.

Notes/Script:

Ellen: Okay. So, in general whatsoever once and of course, font this is what we want in is to see at the ends to visualise for sport teachers, if they are in a healthy environment, yes or no, if they have, if the sun level is too high during the day what can they do to have to organise, maybe reorganise their work or their activities or, and get insights in what the sound level is, or maybe not like number of some level but more they get feedback that they should be careful or should take actions or something to change their behaviour, maybe their environment. So, what do we want to do? So, we have two goals. One is to help to improve the sports halls. So it's not really related to your goal. That's the use of this picture. I will I would like to give the manufacturers of the holes inside in what are the main reflective areas. So they can put some sorption material there or

Wolf a new solution for that.

Ellen Yeah. That's one of the goals we have for some ammo. And also for the subsidy. It's not directly related to or it's a device.

Wolf But it's still interesting information to know about. Yeah.

Ellen But the other one that's interesting and directly related to you is that what I would like to do is to see, can we make some kind of soundscapes so bad officials? To see if can we make a characterization of, for example, an activity that has a low Sharpe level compared to a high some level activity. So is there a difference between children doing football ball or Yeah, are? Here I have the pictures. These are three deputies. So can I see if can I make a visual directly to sounds or to the sound level or something? To show the differences, you have to show the difference. And I'm talking about since skaters or soundscapes and you have a landscape where you can see outside the park, for example, and soundscape is can I see the difference? Areas

Wolf like sound map, like how heat map looks

Ellen like a heat map. But then for sounds, we can see high pressure, low pressure, and high sound levels. So that's the second goal. And it was a challenging one because we'd never done it before. But that's nice about subsidies that you can also

Wolf Yeah, it's good for innovation. Yeah, that's

Ellen good for innovation. So for example, what you saw was this one. So here I did the basketball. I don't know the English word for voting. And then we could see here the reflections. I can also show you the recording if you weren't

Wolf shown in real time. Sorry. Yeah. So that you can actually see in real time Yeah, I can show you try to find the correct one for this one. Because that will be interesting to know if you're showcasing if it's possible to showcase it in real time, then you can also make when you want to showcase that data to the PE teacher. The data is not from before, but you can actually show them right now. It's too loud for you.

Ellen Yes. And no. Yeah, that's thanks. I think the aim that we both have. Exactly, yeah. What do you see what Paul says? rebound suit. You can notice Yeah, so yeah, I think let's see where I'm standing now. This one,

Wolf oh, no. Oh, not stopped

Ellen I'm standing here here, we've been seeing the movie moving. It's a bit bit difficult to see. But what you can see is the reflexive reaction of the reflections on, and especially on this side and on the other sides. And here you don't see really reflections. It's very like momentarily, so you can see it switches quickly.

Wolf Like, imagine if it's a basketball game, for example, the ball is rapidly bouncing. So these rapid reflections,

Ellen yeah, so we also need to learn, let's say, what is the reaction? Yeah, it's not really, it's the Borel accuracy. So I also need to learn when I, because the, the camera has worked in frames, different frames, making recording, then another recording calculates the difference. And if you have, like, in bills, this is an impulse. So when it's really short and bills can happen, that's the frame refreshing your frames is not related to that sounds. So if it just refreshes, I do at the same time this and then they won't stop. This is actually also a challenge.

Wolf What would the solution be having quicker? Recordings?

Ellen Yeah, we call recordings or you accept the fact that you have directly can measure impulse as follows. So when I noticed, when we did the measurements with the children, that the children are way louder than the sound of the bouncing ball? So for this research, it's it's not really a problem? Because I think we have to focus on the sound of the data children.

Wolf Not the sports that they play.

Ellen No. anymore when to be answered. Yes, then you don't so yeah, but I share with you all, yeah. But yeah, we can, what we can do is I can analyze the data, then we can really go from frame to frame we can make a better understanding of what's what is happening there. But this is what you saw, maybe this, this is answering yes. Okay. And the other so when we look at what it's gonna do, then I can make an average sound map. So you can make for example, a recording of let's say, five

minutes, or one minute, we can also see at the end that the device, maybe it's not really necessary to have maybe an in situ or instantaneous feedback. You can also say we make a feedback after five minutes or after 10 minutes or Wolf intervals. Yeah. Ellen So for example, if I make a recording of of of an activity, I can see okay, what is not what is the average Ching over a certain amount of time and what what I noticed here is that when children are screaming, within two metres from the wall, then you have also the reflection. Okay, and if you have in sounds, there is a rule that if you have one sound source For example, at sml, you have two sound scores with the same decibel. And it's three decibel more to combine this at three, but it translated to that it is twice as much sounds. That's something that's, that's so.

Wolf fun. That's even more, right.

Ellen So 80 and 80 is not taller than 60 dB at three dB, but it's actually two times more power. So

Wolf does that multiply? So let's say a group of 10 kids, and they all speaking at 80 DB?

Ellen Yeah, so let's keep it simple. Yeah. Yeah. So we have one source 80 DB, to source HPV is 83. Together for sources says as two times six, okay. Okay. So everything you multiply with two. Let's keep it simple. Yeah, it's three dB. On top of that. So if you for example, now we know we did some measurements in this fall. And we see that for hold.

Conclusion and recommendation

The expert interview proved to be instrumental in identifying the key challenges related to measuring sound levels in sports halls, along with potential solutions to mitigate them. The interviewee proposed several recommendations, such as employing soundscapes to analyze and characterize activities with varying noise levels, incorporating holes in the walls of primary sound reflective areas to accommodate absorption materials, and generating an average sound map to address issues arising from impulse sounds. These invaluable insights will shape our project strategy and facilitate the creation of an efficient solution.

Question: How can valuable insights be presented to the end users?

Method: Competitor Analysis

Why: It provides a thorough understanding of the applications within this market domain, encompassing the identification of key players, examination of their strengths and weaknesses, and gaining insights into their product offerings and strategies.

How: I selected and evaluated two sound applications, namely Sound Meter and Sound Tools SVM. I discovered them by conducting an internet search using the keywords "sound meter mobile apps" and came across a list with detailed descriptions. Both applications appeared to be pertinent and received positive reviews on both the Apple App Store and Google Play. I compiled the main insights and key takeaways, which are summarized below.

Results:

Key insights and takeaways:

- Free app, no microtransactions or subscriptions.
- Indicator for max, min, and average decibels.
- Sound meter up to 100 decibels.
- Colour indicators for healthy, and unhealthy decibels
- Reference to current sound level with different environments.
- Possibility to calibrate the microphone.
- Graph that illustrates sound levels per second.
- Possibility to save a short report which gives an overview of the recorded sound levels.
- Indicator for max, min, and average decibels.
- Navigation UI is hard to understand.
- No information about the calibration and why should you calibrate the microphone before the recording.
- Sound meter is limited to 100 decibels.
- Won't be as accurate as a professional tool for sound measurements.
- No information on why certain sound levels could be harmful to humans.

Conclusion and recommendation

After evaluating the Sound Meter and Sound Tools SVM apps, it can be concluded that both apps have their strengths and limitations. They offer useful features such as free usage, indicators for max, min, and average decibels, and the ability to save reports summarizing sound levels. However, there are some drawbacks, including a limited sound meter range of up to 100 decibels, a difficult-to-understand navigation UI in Sound Tools SVM, and a lack of information regarding microphone calibration and potential health risks associated with certain sound levels. While these apps serve general sound measurement purposes, they may not provide the same precision as professional tools. Overall, improvements in UI clarity, calibration guidance, and user education on sound-related risks would enhance their usability and effectiveness.