MESG

MESTRADO EM ENGENHARIA DE SERVIÇOS E GESTÃO

Community' Services on STEAM Education and Sustainable Development

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Master Thesis

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To my "future" family…

Abstract

The ERASMUS + project named "MiniOpenLab – Open community and Hands-on approach to Sustainable Development and STEM Education", defends that both Sustainable Development and STEAM should be addressed from an early age, at school, motivating students to learn maths, science, to imagine working in these fields, to learn about sustainability and develop attitudes and behaviours that are in line with the UN's sustainable development goals. To diffuse STEAM education and ESD a small laboratory, MiniOpenLab, was created and is open to the local community, where children engage in STEAM-based projects on sustainable development. This dissertation intends to contribute to this project with the design of a community' service to be implemented at the MiniOpenLab.

To achieve that, a service was designed using the service design tools. The service design process starts an exploration phase with identification and understanding of the user, and for that, interviews and focus groups were used; follow by an ideation phase with a benchmarking supported on interviews, service design tools with a user journey and service navigation; and ending with a prototype to test the concept and collect feedback.

During the exploration phase it was possible, grouped by dimensions, understand what elements in sharing service the users, parents and children, appreciate more. In ideation phase it was possible to identify other sharing services and understand, again by dimensions, what are the good practices to insert and what can be improved. Personas for parents and children were build and all knowledge was translated into recommendations for design service. Service designed started with user journey building, representing that interaction between user and service; and ended with service navigation; divided between a workshop service and an open space service, where activities were designed in specific for creation and retention of the community. In the end, a prototype workshop was made to test the concept and where it was possible to identify positive aspects to amplified, aspects to improve and insights to be aware about the service.

With this dissertation it was possible to identify some requirements for community' services: the importance of creating, engage and retain communities and language consistency. And also some key success factors for sharing services in school context: the existence of a community, the support for the user and community member and the intrinsic motivation associated to the service and to the community.

Keywords: STEAM, service design, sharing economy, community' services

Resumo

O projeto ERAMUS+ denominado "MiniOpenLab – Comunidade aberta e abordagem prática para desenvolvimento sustentável e educação STEM", defende que tanto o desenvolvimento sustentável como as áreas STEAM devem ser endereçados desde início, na escola, motivando os estudantes para aprender matemática, ciências para que se imaginem a trabalhar nestas áreas, a aprender sobre sustentabilidade e a desenvolver atitudes e comportamentos que estão alinhados com os objetivos de desenvolvimento sustentável das Nações Unidas. Para difundir a Educação STEAM e os objetivos de desenvolvimento sustentável, um pequeno laboratório chamado MiniOpenLab foi criado e está aberto para a comunidade para que as crianças possam ligar-se a projetos baseados nas áreas STEAM e em desenvolvimento sustentável. Esta dissertação pretende contribuir para este projeto com o design de um serviço para a comunidade a ser implementado no MiniOpenLab.

Para atingir isso, um serviço foi desenhado com base nas ferramentas de desenho de serviço. O processo do desenho do serviço começa com uma fase de exploração com identificação e conhecimento dos utilizadores, em que para isso se utilizaram entrevistas e grupos de foco; seguido de uma fase de ideação com um benchmarking suportado em entrevistas e ferramentas de desenho de serviço como a jornada do utilizador e navegação do serviço; e terminando com um workshop protótipo para testar o conceito e recolher feedback.

Da fase de exploração, foi possível, agrupando por dimensões, perceber quais os elementos no serviço de partilha que os utilizadores, pais e alunos, dão mais valor. Na fase de ideação conseguimos identificar outras serviços de partilha e perceber, novamente por dimensões, quais as boas práticas a introduzir e o que pode ser melhorado. Construímos ainda personas para pais e crianças e agrupamos todo o conhecimento em recomendações a ter em conta no desenho do serviço. O desenho do serviço começou com a construção da jornada do utilizador, representando como é que o mesmo interage com o serviço, e terminou com a navegação do serviço, dividida num serviço de workshop e um serviço de espaço aberto, onde foram desenhadas atividades especificamente para a criação e manutenção da comunidade. No final, foi realizada um workshop protótipo para testar o conceito e no qual podemos identificar aspetos positivos a amplificar, aspetos a melhorar e algumas perceções a ter em conta no serviço.

Com esta dissertação, conseguimos identificar alguns requisitos a ter em conta no desenho de serviços para comunidades, como a importância de criar, ligar e reter comunidades e a consistência a linguagem. Mas também alguns elementos-chave para o sucesso de serviços de partilha, especialmente em contexto escolar, como a existência de uma comunidade, o suporte para o utilizador e membro da comunidade e a motivação intrínseca associada ao serviço e à comunidade.

Palavras-chaves: STEAM, desenho de serviços, economia de partilha, serviços para comunidades

Acknowledges

I would like to thank deeply to my supervisors, Prof. Teresa Sarmento and Sónia Nunes, from CEiiA, for all the support and contribution to this project. A special thank you to Sofia and Ana from Scholé, as well as the children and parents that participated on focus groups and the workshop. Another special thank you to the spaces whose managers I had the privilege to interview: VivaLab, Escola EB 2,3 de Abação (Biblioteca and Sala do Futuro), Biblioteca FEUP, Penas Surf School, START Esposende and PENHA Centro Escutista.

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The dearest thanks to my André, for the support during this adventure. And an apology for all the time I was unavailable and for the delay in our plans.

Finally, I need to thank to my family; my mom, dad, and brothers; for all the love and understanding. To the family Faria and Ribeiro, my dear Afonso and Luzia, and to all my friends (I will promise to have more time now).

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CEiiA – Center of Engineering and Product Development

ESD – Education for Sustainable Development

FAQ's – Frequently Asked Questions

STEM – Science, Technology, Engineering and Mathematics

STEAM – Science, Technology, Engineering, Arts and Mathematics

UN – United Nations

UNESCO – United Nations Educational, Scientific and Cultural Organization

1 Introduction

Project background

United Nations (UN) defined that from 2005 to 2014 was the Decade of Education for Sustainable Development (ESD). After that, United Nations Educational, Scientific and Cultural Organization (UNESCO) created the Global Action Programme on ESD (Laurie et al., 2016). According to the Report of Science Education for Responsible Citizenship,

> *The European Union has set ambitious goals: to promote smart, sustainable, and inclusive growth, to find pathways to create new jobs and to offer a sense of direction to our societies. This requires significant strengthening of our knowledge and innovation capacity and our creative capability as drivers for future growth* (Hazelkorn et al., 2015).

UN defines ESD has an approach to equally address three pillars of sustainable development – society, environment, and economy in a holistic manner, enabling all individuals develop knowledge, perspectives, values, and skills in take part in decisions to improve quality of life (Venkataraman, 2009). Based on the principles associated to the concept of ESD, a 21st century education should incorporate some values as: citizenship education, global issues and interdisciplinarity (P. C. Taylor, 2016).

On the other hand, STEAM (Science, Technology, Engineering, Arts and Mathematics) Education is key for an increasingly complex knowledge-based society. "Knowledge of and about science are integral to preparing our population to be actively engaged and responsible citizens, creative and innovative, able to work collaboratively and fully aware of and conversant with the complex challenges facing society" (Hazelkorn et al., 2015).

Based on this need, it was approved in 2020 the ERASMUS + project named "MiniOpenLab – Open community and Hands-on approach to Sustainable Development and STEM Education", defending that both Sustainable Development and STEAM should be addressed from an early age, at school, motivating students to learn maths, science, to imagine working in these fields, to learn about sustainability and develop attitudes and behaviours that are in line with the UN's sustainable development goals.

The project approach to diffuse STEAM education and ESD is through small laboratories, MiniOpenLabs, open to the local community, where children engage in STEAM-based projects on sustainable development.

This dissertation intends to contribute to this project with the design of a community service's to be implemented at the MiniOpenLab, addressing topics related with identification of types of users, engagement, the use of the lab, sustainability, among others. For the design of the new service for MiniOpenLab community, the specific research questions bellow are suggested:

RQ1: What design requirements should be considered in communities' services?

RQ2: What are the key success factors on a sharing service for a school context?

To address the questions, a qualitative method was applied to characterize different types of users and understand needs, expectations, and beliefs regarding the MiniOpenLab' services.

Some dimensions of the service emerged from analysis, such as time and space management, marketing and access, training and support and financial sustainability.

This dissertation is divided in six chapters, addressing the introduction, the literature review, the problem characterization, the methodology, the results, and the conclusion.

The first chapter is an introduction to the dissertation theme, characterizing the project background and the organizations that are part the project. It is also referred the problem this dissertation is trying to solve and the defined research questions that serve as a basis for the following work.

In the second chapter, is presented the review of the existing literature regarding STEAM and sustainable development areas, the definition and what is being made now to promote these areas; the concept of sharing and sharing economy, some initiatives that are being made on that area and the challenges find until now and the community definitions. To finalize the literature review and to support he methodology, there are reviewed some concepts of service design, common methodologies and how to co-create value in the education area.

The third chapter is where the problem is presented with more detail, enabling a better understanding and characterization based on the literature existing on this topic, and contextualized in the education area.

In the fourth chapter is presented the methodology to be applied across this dissertation project, divided in the different phases.

The fifth chapter presents what was made and the results of each phase of the methodology.

And the last chapter, sixth, the conclusion, presents the main conclusions about this dissertation and what is the scientifical contribution that this dissertation has been able to produce.

2 Literature Review

Considering that the aim of this dissertation is based on the idea of a service for a lab to share resources promoting STEAM areas, it was relevant to list some concepts as: STEAM Education, Sustainable development, Sharing economy, Living labs, makers spaces and fab labs, Service design and Communities, presenting definitions and challenges; to a better understand of the methodology to apply to this dissertation.

STEAM education

The STEAM concept is a result of modernization of education system to follow human evolution events, for example, the fourth industrial revolution. The initials of STEAM correspond to Science, Technology, Engineering, Arts and Mathematic (Malele & Ramaboka, 2020). This concept uses an interdisciplinary or transdisciplinary approach to teaching and learning (Perignat & Katz-Buonincontro, 2019). It is also described has the intuit of prepare children for 21st century, with the ability to think smart and creatively, solve problems, persist, and take risks, have strong digital skills, and know how to collaborate effectively (P. C. Taylor, 2016).

The drivers of STEAM-centred education are cross-disciplinarity and exposing learners to multiple, lateral, and creative thinking ways (Malele & Ramaboka, 2020). Students exposed to this curriculum work in learning environments supported by design thinking, a new approach to solving problems and generating innovative solutions. In the STEAM education model, there is a belief that it is possible to be open, active, exploratory, flexible, and unique problem solvers and that one definition of being creative. To better deal with the complexity and multidimensionality of sustainable future technologies, it is necessary to have a holistic approach, combining creativity with technical skills from traditional education methods. This approach creates a more holistic workforce (Skowronek et al., 2022).

Across the world, STEM education is taken place in many country's education systems, since the United States to China, Korea, Japan, and Germany (Aktürk, 2017). Since primary schools, to elementary and universities, here are some practical examples of what is being made to promote STEAM education.

In the USA, educators promoted STEAM with a robot-theatre program in both primary and elementary schools. The program increased students' engagement and interest in STEAM and robotics and also promoted the development of different development stages and learning skills (Ko et al., 2020).

In Hong Kong, they used an invention kit named "Makey makey" to understanding the process of facilitating creative thinking in STEAM education on an elementary school. Besides the accomplishment of the defined goals, where students learned how to play, learn, and design for themselves, was also noticed that the relationship between educators and students changed from knowledge-based to research-based one (Chen & Lo, 2019).

On a high school in Indonesia, they compared the capacity of mastering a concept before and after applying STEAM approach to the theme "Water and us". The results show that using STEAM approach, students can more easily understand the concept, explore their inner potential, and awake students in themes of thinking, creativity, and character (Liliawati et al., 2018).

On a South Africa university, a group of computer systems engineering students was submitted to a challenge based on a problem-solving case-study with IDEAL framework and woods method, where they had to design, build, and test a prototype of an automated plant watering or irrigation system using any wireless or mobile concepts (Malele & Ramaboka, 2020).

A lot has been made to promote STEAM education in different countries, with students of different ages and with deep changes on the curriculum offered by institutions (Telefonica et al., 2014). However, there more examples of practical and one-time applications of challenges to promote STEAM education in universities and for universities students, and just a few practical examples of approaches with and for primary students.

Sustainable development

According to the Brundtland Commission, sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their needs." (Commission on Environment, 1987).

The UN declared in 2002 that between 2005-2014 was the decade for ESD, defining that ESD should address all three pillars of sustainable development, society, environment, and economy, and culture, embracing these elements in a holistic and integrated manner, enabling all individuals develop knowledge, perspectives, values, and skills to take part in decisions to improve quality of life.(Venkataraman, 2009).

Robert Laurie published an article in 2016 that replies to the questions in our minds, but how can ESD guide students to have the knowledge, skills, and values to care for and solve the sustainable development issues that will arise in their lifetime? And the answer was that ESD also works the process of finding the appropriate solution for a problem (the problem-solving skill), contributes to the development of student's abilities and confidence, through a constant interaction and evolvement (Laurie et al., 2016).

A lot of different approaches had been taken to transform education to incorporate these concepts. In India, a group of professors identified some disruptive technologies that can support a sustainable education future, enumerating online learning, chat-based platforms, competency-based education, virtual reality, artificial intelligence, case based or project bases instruction, augmented reality, the internet of things, STEAM, gamification, immersive experiential learning and blockchain (Gejendhiran et al., 2020).

In Spain, Sanchez-Carrillo performed a systematic literature review about strategies to pursuing adoption of sustainability in higher-education, some of them are integral transformation of the identity of each institution, openness within the structure and management, explicit formation and training of educators, employees, and managers, putting the community in the centre of sustainable practices and collaboration with several higher education institutions (Sanchez-Carrillo et al., 2021).

More practical examples were reported in Burgos, Spain, where educators promote sustainable mobility in a primary school, with a role-play game. In this game, the educators used an online platform, where they prepared a story and design a set of activities that students must negotiate to win points and rewards. The conclusion of the adoption of different approaches to promote sustainable concepts is that besides understanding sustainable mobility and sustainable cities concepts, the students also understand the importance of social and economic components of sustainability and started developing awareness of how to play an active role in changing their conduct (Sipone et al., 2019).

The sharing economy

Nowadays, social, and technological forces can drive people apart; the relation that still connects people is sharing. Four key attributes can characterize the sharing practice:

- The recirculation of goods
- An increase in the utilization of durable assets
- Exchange of services and sharing of productive assets

A commitment for sustainability and collaborative consumption and a change of mindset: access assets instead of owning them can also characterize this concept of sharing (Chan & Zhang, 2020).

According to Jeffrey Chan in the book "Sharing by Design", sharing is a way of dividing or distributing resources; can imply the state of having something common with someone; can be a communication act when we share feelings or emotions and can be used to exemplify the return to a more superior and natural state of being (Chan & Zhang, 2020).

Sharing can be a social act and that is explain by three social traits. Sharing is defined as a prosocial and non-reciprocal behavior, so the motivation of sharing is not related with self-interest but with help, empathy, fairness, selflessness, and equality, and give without expecting to receive nothing in return. Another is because sharing usually defines something as outs instead of mine, bringing the possibility of enjoying the benefits from possessing something together, but also the responsibility for sustaining the shared and the sharing practice, a responsibility that led to form a sense of togetherness. As said before, sharing is an act that connects people, creating trust and bonding, and contributing to build a sense of community (Chan & Zhang, 2020).

Mokter Hossain, from the Center for Entrepreneurship of the University of Qatar, made a comprehensive literature review of sharing economy, and a balance definition of this concept is that sharing economy is a socio-economic system enabling an intermediated set of exchanges of goods and services between individuals and organizations which aim to increase efficiency and optimization of sub-utilized resources in society (Hossain, 2020).

As presented in figure 1, the key to sharing economy is motivation, and then the sharing economy needs to be introduced into the business model and revenue model. The use of sharing economy in the models will produce economic, social, and environmental impacts, translated into sustainable development. The stakeholders will impact it, the challenges, and the policy and the regulation (Hossain, 2020).

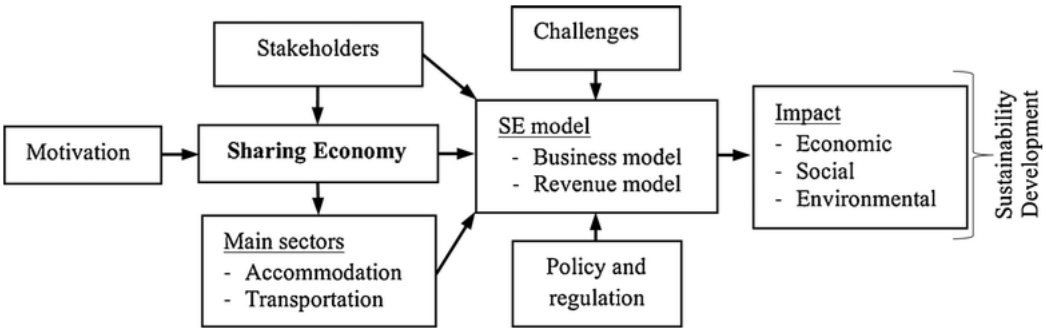

Figure 1 – Framework of various facets of sharing economy (Hossain, 2020).

Living labs, makers spacers and fablabs

Sustainable living is living by using few resources as possible and causing the least amount of environmental damage to impact future generations and achieve and maintain a suitable quality of life while reducing to a sustainable level requires a different kind of economy, a sharing economy. Living labs provide a setting for research on innovative everyday practice, facilitating innovation processes and engaging all stakeholders in real-life contexts (Keyson et al., 2016).

Living lab can be defined as user-centred, open innovation ecosystems based on a systematic user co-creation approach in partnerships, integrating research and innovation processes in real life communities and settings. First, is a place in a real-world setting where several stakeholders from different organizations and expertise interact. Second, the users have an active role as co-innovators, including creating, prototyping, validating, and testing products, services, systems, and technologies. Third, different research teams can work together facilitating the multidisciplinary dimension to achieve goals. And fourth, is a space to physically and virtual collaboration to create the desired outcome (Steen & van Bueren, 2017).

Open-innovation networks can be found in the environment of living labs, offering a research think-tank and innovation platform that can helps innovators apply user-driven innovation practices (Leminen et al., 2012).

The urban living labs can be defined as a wide variety of local experimental project of a participatory nature, aiming to develop, try and test out innovative urban solutions in a real-life context (Steen & van Bueren, 2017).

The concept of *Fablabs* was created in Massachusetts Institute of Technology Center for Bits and Atoms in 2003 and defined as physical spaces equipped with specific low-cost technological infrastructures for digital fabrication where people meet to invent and make anything together. Fablabs are platforms for learning and innovation, where design and production industries meet, and can also contribute to incubating proactive minds (Botleng et al., 2017).

As Botleng says,

> *Fablabs should be able to integrate design and production, providing a sustainable digital technological infrastructure, enhancing collaboration trough digital networking, be responsive to resource conservation and sustainability (including other concepts as eco-design and circular economy) and cater for constructionist pedagogical approach that fosters creativity, critical thinking, and the development of Science, Technology, Engineering and Mathematics (STEM) skills* (Botleng et al., 2017).

The need for physical spaces emerged in the recent years much related by the lasted trends: the digitisation trough 3D printing and digital technologies moving from online environments to the physical world. This kind of spaces provides access to digital manufacturing technologies, requiring for the users to develop new skills - creative thinking, recourse management, planning, self-efficacy, and teamwork - but on the other hand, are also lowering some barriers to entrepreneurship; and driving multidisciplinary – since the users of these spaces can be from different backgrounds (Rayna & Striukova, 2021).

In Rotterdam University, it was created an open fablab course. The course proved that fablabs enable students to use machines and materials, accelerate their ideation and invention processes and students create more professional skills using different machines. Some lessons learned

from that project is that some students struggle creating prototypes in the initially planned time and struggling understand why it went wrong to fix it in the next try (Mostert-Van Der Sar et al., 2013).

Living labs, marker spaces and fablabs could have different activities, involvement degrees, spaces and aims but some practices are overlapping. All concepts provide collective activities based on building and diffusion alternatives and innovative materials (Costa & Vieira Pelegrini, 2017).

Challenges of living labs, makers spaces and fablabs

Living labs have some challenges, and Kris Steen, from Delft University of Technology, made a report with an inventory of living labs that are open and closed, identified some differences between them and some lessons learned (Steen & van Bueren, 2017).

Some challenges are related with the stakeholders not knowing what is supposed to do in a living lab, others with the involvement or not of the users. Only when users participate on the development of innovation we can talk in co-creation, a key distinctive feature of these labs (Steen & van Bueren, 2017).

Service Design

Birgit Mager, also known as one of the creators of the Service Design discipline, wrote a book in 2008 named "Service Design: An emerging field", where she explains not only the definition but also the context behind the creation of the concept. In her book, she explains that service design addresses the functionality and form of services from the perspective of the user, ensuring that service interfaces are useful, usable, and desirable from the user's point of view, but also practical, efficient, and distinctive from the owners/manager point of view. Service design also integrates the possibilities and means to perform a service with desired qualities and an organization's economic and strategic intent (Mager, 2008).

Community

When thinking about communities, the feeling is that is a concept that it is known for all and understand so there is no need to search for definitions in the literature. However, translate to words the definition of community is not easy. That why in the literature, the definition of community is not the same for all authors.

Taylor and Hurley decided to study the role of makerspaces in public life, because according to Fab Charter, fab labs are community spaces; makerspaces can be also community centre since they are both a community space and a space for communities; makerspaces in libraries are places of community activity and information; and for these spaces, the most valuable resource is the community. And one of their conclusions is that makerspaces should be taken seriously as a resource for the community (N. Taylor et al., 2016).

During this research, it was found a case prepared by the Harvard Business School about a company – MindTree – that since that start, their founders envisioned that knowledge management would play a key role at the firm, and the way of reflecting the socio-technical approach to knowledge management was trough communities of practice (*MindTree: A Community of Communities*, 2010). According to MindTree vision, forming a community – "a group of people who share a common passion, that decided to get together for learning,

knowledge sharing, business development and self-development" – is easy. With the time, they created a community maturity model, saying that after the creation, the community evolves trough different status, present at figure 2: community of interest, competency building, capability building and capacity building. However, create a successful community is difficult because to survive, a community needs: participation from several passionate people and a common purpose across the members (*MindTree: A Community of Communities*, 2010).

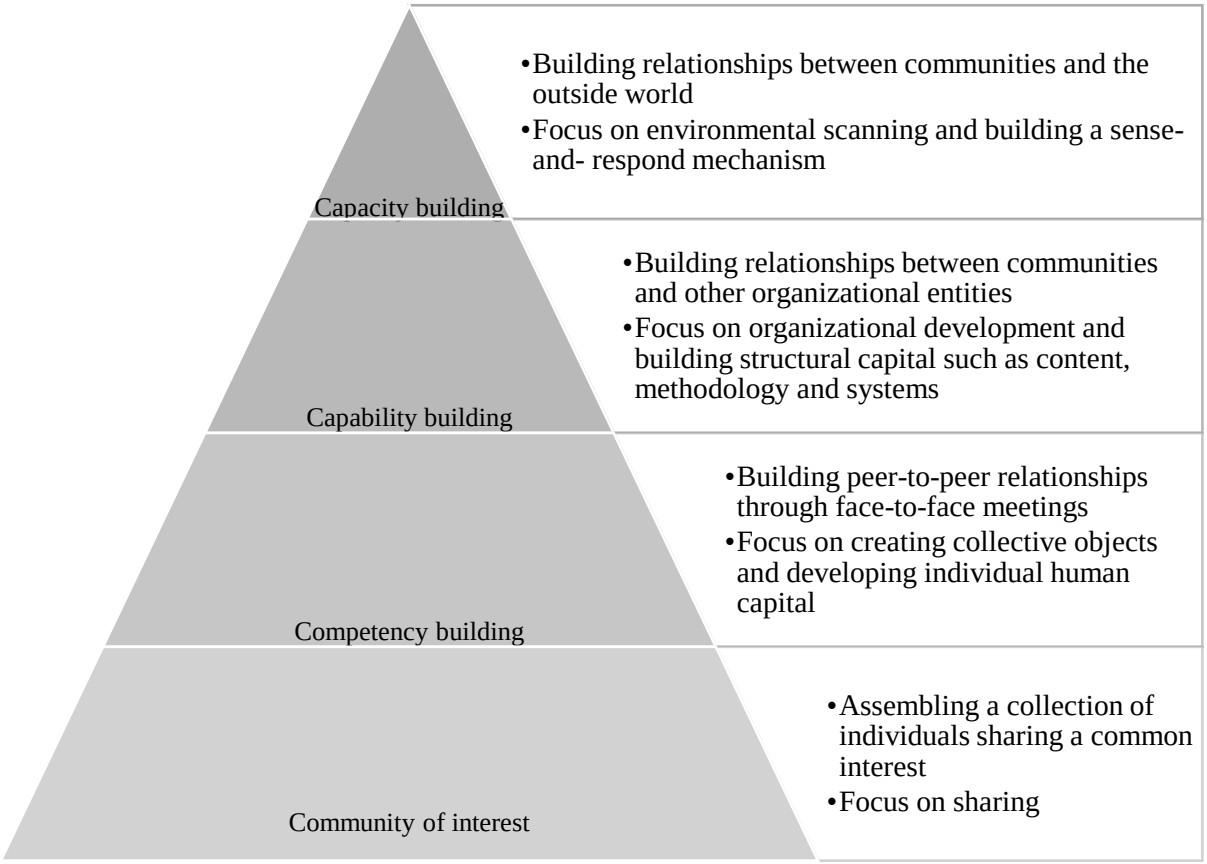

Figure 2 – Community mature model by MindTree (*MindTree: A Community of Communities*, 2010).

According to Richard Millington, the author of the book "Buzzing Communities", there are 5 types of communities:

interest – communities of people who share the same interest or passion.

action – communities of people trying to bring out change.

place – communities of people brought together by geographic boundaries.

practice – communities of people in the same profession or undertake the same activities.

and circumstance - communities of people brought together by external events or situations (Richard Millington, 2013).

3 Problem Characterization

CEiiA, the organization under this research, is the Centre of Engineering and Product Development that designs, develops, and operates innovative products in the mobility industries, namely Automotive and Urban Mobility, Aeronautics, Ocean and Space. IS also one of the 10 largest R&D investors in Portugal and an international reference in the sustainable mobility area and recognized in the aeronautical world for our skills in structural engineer (CEiiA ©, 2020).

This organization has been working on creating and defining communities for them; a community is a group of people that, interacting to achieve a common goal, generate an aggregated value for their members that is significantly higher than the value generated individually. The cohesion between the members is crucial for the quality of their contributions, and it is enhanced through sharing a common purpose and creating relationships of respect, affinity, and confidence. CEiiA also defines a network as an aggregated of people that share the use of something, a service, device, physical or virtual space) trough conditions defined by the owner to satisfy individual or collective needs.

Has mentioned before, this dissertation is inserted on an ERAMUS+ project named "MiniOpenLab – Open community and Hands-on approach to Sustainable Development and STEAM Education" which main goal is to set-up and test an open community and hands-on approach to Sustainable Development and STEAM Education of children (6-12 years old), through a MiniOpenLabs: a small laboratories, open to the local community, where children, under the guidance of teachers or other educators (including parents), may engage in STEAM-based projects on sustainable development (Universidad Rey Juan Carlos et al., 2020). Scholé, a private school for children and youth between 3 to 10 years old, is also part of this project. MiniOpenLab space is part of Scholé school and the space, as presented in figure 3, already has a 3D printer, a laser cutter and printer, a thermoplastic moulding machine, multiple computers, and Arduino's (CEiiA & Scholé, 2020).

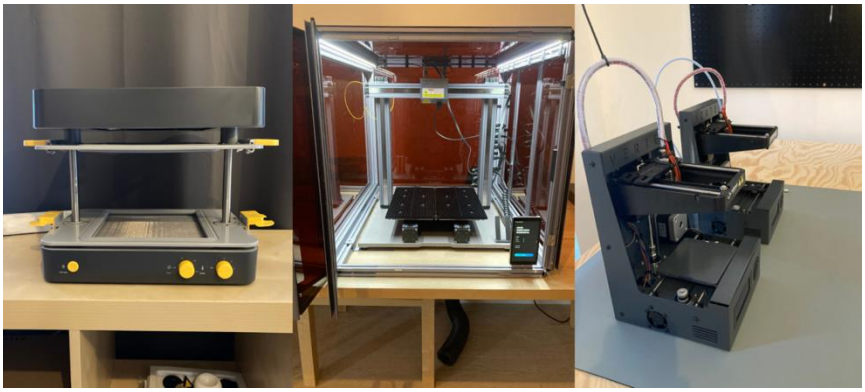

Figure 3 - MiniOpenLab equipment.

Is not enough to create a laboratory with different equipment to promote STEAM education and sustainable development, it's necessary to engage the community to use the laboratory and use in an autonomous way. To enhance the resources is necessary to share the resources, giving the opportunity to more users, students, educators, and parents, to use them and taking advantage of them.

Based on the literature reviewed in the chapter 2, there are different ways of creating a space open to a community to share resources, support and catalyse ideation and diffuse concepts regarding sustainable development and STEAM. There are living labs, makers spaces and fablabs. MiniOpenLabs will be distinct, created with having for a target of children and adults and with a new service specific designed for this target and focused on the use of this laboratory by the community, with a co-creation of value with the users of the laboratory.

To achieve that, a service will be design using the service design tools that can easy map with the aim of the service. The service design process starts with identification and understanding of the user, and for that, interviews and focus groups were used. Service design tools chosen were customer journey and service navigation. In the end, a prototype will be made to test the concept and collect feedback.

4 Methodology for the service design

Service design is traditionally viewed as a specific stage of the new service development process, but now it is also involving understanding users and their context, the service providers, and social practices, and translate all that information to the development of evidence and service systems interaction (Patrício et al., 2011).

Based on the multilevel service design approach of Patrício et al. (2011), figure 4, the first phase is observation and investigation of the current situation; second phase is forming a bridge between problem and solution, by helping interpret and systematize the information collected in phase one and explore new potential solutions, and third phase is idealized solutions in an iterative process and then into prototypes (Patrício et al., 2011).

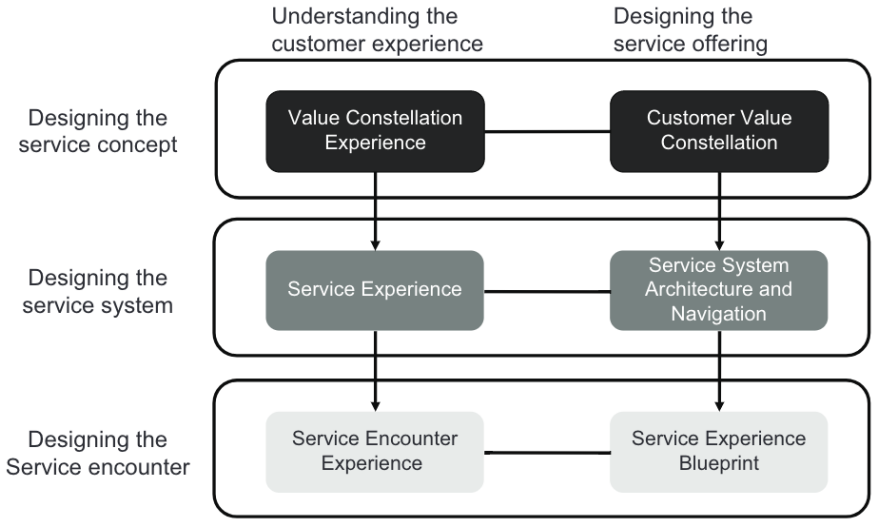

Figure 4 – General model of multilevel service design (Patrício et al., 2011).

To understand the user, the most relevant analysis is the qualitative, which emphasizes words rather than quantification in data collection and analysis. It is possible to note that the qualitative approach is used when interviews or observations are required since "qualitative research may serve the researcher's needs better since it is typically associated with the generation rather than the testing of theory". For this project, it is appropriate to collect data with procedures involving interviews and observations as well as other sources that may shed light on questions under study (Corbin & Strauss, 1990).

To complement, customer experience modelling is a method to collect elements to portray an experience that synthesizes and represents customer experience to support service. In this case, adapted to user experience modelling, since are not clients involved, but users (Teixeira et al., 2012b).

In this methodology, is important to understand that the outcome is a service, so a methodology for service creation and design needs to be adopted. In the ideation phase of the service design is also important to collect some approaches for sharing resources services. Shared systems can be defined as systems that provide a broad-based access and usage of a resource that is held in common. According to Ostrom, there are eight design principles to successful common-pool resources: clearly defined boundaries; congruence between appropriation and provision rules and local conditions; collective-choice arrangements; monitoring; graduated sanctions;

conflict-resolution mechanisms; minimal recognition of rights to organize; nested enterprises (Chan & Zhang, 2020).

In the creation of a sharing service, as living labs, the report elaborated by Kris Steen suggests a methodology: initiation, plan development, co-creative design, implementation, evaluation, refinement, and replication. One of the most important phases is the co-creative design, suggesting for that phase, the creation of a network-collaboration in a setting of equal interests, a flexible institutional framework, the realization of constructive and inspiring co-creation sessions and having the right mindset based on trust and accepting uncertainty (Steen & van Bueren, 2017).

Method used in this project

The approach to data gathering is divided in three phases, as presented in figure 5, the first one is exploration phase, the second is the ideation phase and the third is the prototype phase.

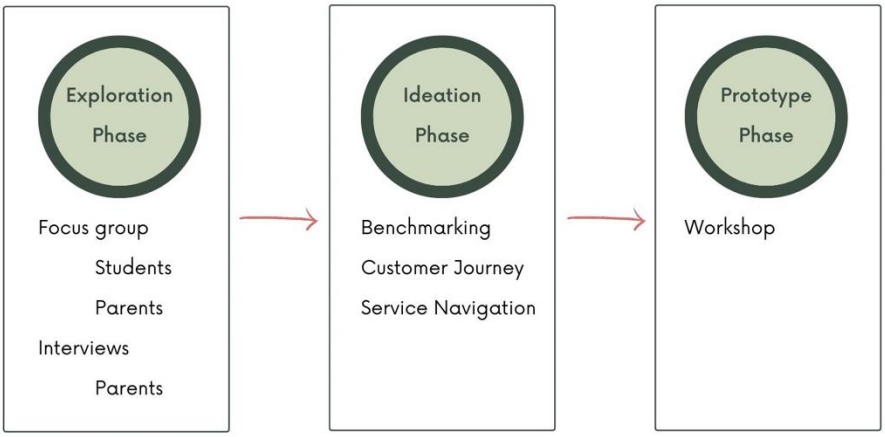

Figure 5 - Method used in this project.

The **Exploration phase** is to explore and understand the user. For that a field research protocol, that includes interviews and focus groups for each type of user, was created. For focus group the ideal number is between 5 to 8 participants, and a script could be the conduction of the event (Bryman, 2006).

The MiniOpenLab users can be parents and students. For students, a focus group was conducted with 6 students, physically and the event was video, and audio recorded to habilitate the transcription of it. The script was developed with open questions and structured from less detail to more detail questions, starting with questions about STEAM and sustainability questions, to performing activities in the space and then visit the space with parents and how could it work. The script for a focus group with students, that are children, needs to be different: the time is important to keep children focused and concentrated in the event, and the use of visual components could be more insightfully. Based on that, to understand the importance of STEAM areas, images of activities associated or not with STEAM areas were presented and it was asked to the students to separate the images in two groups and see if they could correctly associate the activities with STEAM areas. When asking about the use of that space, the lab, it was also reproduced a video of a 3D printer working, adding a visual component to the question. The full script if presented in Appendix A.

With parents, a focus group was equally made physically and conducted with a script, presented in Appendix B, with 7 parents, and the event was video, and audio recorded to habilitate the transcription of it. The script was developed with open questions and structured from less detail to more detail questions, starting with questions about STEAM and sustainability questions, to performing activities in the space and then visit the space with parents and how could it work.

To have a different perspective outside of Scholé, two interviews were also performed to parents, following a semi-structured interview with support of a script, presented in Appendix C. Both focus group and interviews went through a full-transcription process.

For the second phase, the **Ideation Phase**, it was also essential to perform a benchmarking that included the identification of places that are using sharing services and a more detailed description of the service. To collect detailed information about these services, 7 managers of sharing service spaces were interviewed, personally or via zoom. The interviews went through a full-transcription process, and data collected about the sharing services was organized in categories:

- Purpose and target
- Marketing and access
- Shared resources and procedures
- Activities and program
- Time management
- Space management, staff, and resources
- Training and support
- Financial sustainability
- Community management and evaluation and feedback

The results of phases one and two were presented to the service owner by new categories:

- Purpose and target – Who do we do this for?
- Marketing and access – How people will get to know us?
- Shared resources and procedures – What and how will we share? And What are the steps that user must do?
- Activities and program – Why will we share it?
- Time management – How will we manage time?
- Space management – How will we manage space?
- Staff and resources – What resources we need?
- Training and support – How to support users?
- Financial sustainability – How to make the space financially sustainable?
- Community management – How to manage MiniOpenLab community?
- Evaluation and feedback – How to know if we are doing a good work?

For each category, the options were identified in the benchmarking and preferences perceived after focus groups and interviews. Based on the selected options, service navigation and service blueprints were produced considering that this is the first draft of community service and its address as a safe zone, a minimum valuable service for this service to be applied to this community also being developed.

To test the concept and collect feedback, a **Prototype Phase** is necessary, where it is possible to create an event, a workshop, to test the prototype designed in Phase II. The workshop has occurred in Scholé space for MiniOpenLab, with 4 parents and 6 students, and the event was video, and audio recorded to habilitate the analysis of it.

5 Results

This chapter presents the main results obtained through the different phases of this dissertation. For each phase, the results and findings are explained.

Phase I – Exploration Phase

The first topic to address was the identification of the possible users to use this MiniOpenLab. It is understanded that the service could be used by students and parents. Interviews and focus groups were made to better understand the user's knowledge about these areas, the motivation to use Open Labs and what could improve the experience of using the service.

Students

For children and youth, the best approach was doing a focus group with 7 students, presented in figure 6, with duration of 35 minutes, in the space of MiniOpenLab. The students are all from Scholé school and with ages from 7 to 9 years old (Bryman, 2006).

To facilitate the dynamic of the focus group, it was used a script, presented on Appendix A.

Figure 6 - Photograph after focus group with Scholé Students, in MiniOpenLab.

After this focus group, was possible to conclude that, for these students, there is a generalized idea of what are STEAM areas and sustainability and what will represent these areas in the future. There is also a curiosity, characteristic of children, of trying and get to know new spaces and activities, with preference for recurrence ones (frequent the MiniOpenLab once for a week).

Some of the children also know already some of the equipment of the lab, what creates right away **motivation** but most of them refer they need an extra motivation to use the lab in first visits: a thematic or a project. Once they are more used to know the space, they could give other uses, for individual projects for example.

All students refer the lack of **physical evidence**, decoration or identification of equipment, or some orientation in the lab. There was some enthusiasm shared about visiting the lab with educators, but in small groups to have space and time for all to use equipment. Some of them would also consider the idea of going with the parents. It was also an interest in having background music in the space and some printed support, like a small book, or instructions about how to use equipment on a video.

Parents

Concerning parents, the approach was different because it was considered important to get to know parents from with in and out of Scholé. So, for the parents of Scholé it was organized a focus group. For parents outside of Scholé, two semi-structured interviews were conducted with two parents. For both initiatives, it was used as a basis the same script. The focus group occurred with the presence of 6 parents, started with a small visit to the MiniOpenLab space, had a duration of 50 minutes and was conducted with the support of the script, presented in appendix B. The profession of parents varied from human science, nature science and technology.

The interviews were made with two parents, the answers are available on appendix E. These parents were classified as extreme users, one is always available to try new activities with the children and the other is not so open to that.

The main difference between the conclusions retrieved from parents inside and out of Scholé is that parents of Scholé showed a true concern about the **sustainability of the space**, unlike the other parents.

The conclusions about the initiatives with parents is that all of them have **a notion about** STEAM and sustainability, but there are not actively worked at home, is a work that starts at school and if children showed interest, they continue to do that work in home.

The **shared services are a reality,** as it possible to see in the quotes 1 and 2, and they are getting more attention with the increase of life cost and conscience about world consumption. For some of the parents it is hard to use these shared services with people outside their trust network, with fear that people outside that network are forced to use the service and that could turn the experience less positive.

> *Q1: "Yes to all, circular economy, they get sick with so much circulating of anything. Almost everything that is reusable. For us, is a reality, the selling/exchange or acquisition".*
>
> *Q2: "I would be willing to share, yes, as long as I felt that the people, I would be sharing with did so willingly and not because they had to."*

It was possible to find out that the motivation to use these services is the potential benefit that could have to the children, but in the same way, what retract parents to use is forcing the children to use it, as it can be understanded from quote 3. So, it needs to be something attractive to the children.

> *Q3: "In my case, I don't do anything with the objective of working specifically some topic, it comes naturally daily (...) We see what she brings back from school and we see how we can relate to activities at home. We don't create a moment, it's something that arises spontaneously and most of the time it's her initiative.*

One of the concerns for parents nowadays is finding the balance between free digital and digital dependency, and it's hard to dose the use of technology but take apart the benefits of using it.

In the specific case of MiniOpenLab, the fear of parents is related with lack of knowledge, as quoted in quote 4, about using the equipment and the possible lack of having a thematic (and decoration) that could be appreciated by the children. To oppose that, they feel that is mandatory having a person supporting all process, since scheduling to clarify doubts until in loco support during the visit. This person should also help in managing expectations and resources during design phase and guide in a more continuous support.

> *Q4: "It's an excellent initiative because if I don't have it at home and I have a space that I can use, I think it's great. I no longer have to make this investment at home, and I can enjoy sharing. Now, to use this equipment, I don't know how to use this equipment, I would need some support or someone who could help me in this regard. Someone who had these skills to help me do certain types of activities."*

Once more, for Scholé parents, the financial sustainability of the space is a concern, as presented in quotes 5 and 6, and charging for some value is essential to force people to understand the value of using the lab. They also suggested an option of "bring your materials or resources) or even having a credit method to teach children the value of money.

> *Q5: "My position is very clear, it cannot be free because otherwise people will not valorize it."*

> *Q6: "There always has to be a cost, even if it is symbolic. It's fun to work like this, a club or an open space, with an associated cost, but not limited to very specific rules."*

It was also reported, as presented in quote 7, that a sense of internal community is important, never using the lab alone to enable the feedback sharing, critical sense and multidisciplinary. However, it should be possible also to engage the external community and add some value to that community because for them, that is the true definition of being sustainable. They also consider that the connection with external community could only be achieved after the financial sustainability of the lab.

> *Q7: "(...) But the advantage is in having more people here and being able to exchange ideas, people who have nothing to do with your area and what you're doing, but they gave a brilliant idea and even helped to unlock something. That's why it's also a space for thinking, and you lose if you don't have a broader critical spirit here, people with a different focus than yours, but they look at that and immediately unlock the problem that you were stuck for 4 hours, one of the advantages of diversity."*

Some suggested were also made for the communication of the MiniOpenLab, both for internal and external community, sharing a positive image of the lab, and that the "open" doesn't mean being always with the door open, but being available on a perspective of sharing. They understand that communicates science is hard, but science is communicated, discuss, and interact.

Some more practical suggestions were made. For the parents that are not involved in STEAM areas, it was suggested to having thematic workshops, as showed in quote 8, for them to get used to the equipment and being more comfortable using them. They also suggested a ticket/reserving system for the equipment.

> *Q8: "Today, prostheses are made using a 3D printer. Maybe there are some dynamics here, different things that enhance the location of the lab and attract people to fidelize them. Then they come for them."*

For thematic ideas, they suggested, as it can be seen in quotes 9 and 10, the presence of a woman in STEAM, repairing toys or giving them life; sex of the animals or any thematic related to the educational program; selling products produced in the lab and having a service that offers solutions to community needs in exchange of any value.

> *Q9: "The concept of open is not that the door is always open. It's really sharing and availability. I know, you don't know, I teach you and share knowledge with you."*

Q10: "Or create this service, if there is a need in the community and the lab, in exchange for a value, responds to that need. In that case of the gentleman from the appliance store who needs the handle, coming here and having the broken part of the tool repaired in exchange for a value."

Phase II – Ideation Phase

Benchmarking

To better understand the market and how existing sharing services work, it was identified some spaces that share resources and interviewed the managers of each one.

The list spaces in which the interviewed managers work included a fab lab, a digital equipped classroom in a public school, a school library, a university library, a surf school, a co-working space, and a scout's camp. All the areas have services focused on sharing resources. The semi-structured interviews add the approximal duration of 50 minutes and some of them occurred physically and other were online, in Zoom platform. All of them were conducted having a script as a basis, presented in appendix C.

To facilitate the understanding and presentation of the main conclusions about this benchmarking it was decided to create categories and classified each service into the created categories: insurance; access, procedures, and operation; space management; staff; return and appreciation; training, support, and physical evidence; and evaluation and feedback.; as presented in Appendix D on a mural board. Some of the spaces had also shared some tips to help the creation of these services.

For each category, it was possible to identify some recommendations or different options for the owner to choose. About the insurance, there are two different types of insurance that these spaces can use: a caution one or an own damages insurance. The access could be made by several channels, but to ensure more support and an easy and more close communication, it is suggested telephone or email. In relation of space management, most of the spaces refer the importance of physical evidence to turn the first visit more positive and autonomous; and this can also influence the children motivation to know the space and feel secure, confidant and comfortable in the lab. There is a concern in decorating the space to support orientation and present what is available. Is also important that the host is available in all visits, at least on a first phase. Regarding the staff, most of the managers advice is to have a multidisciplinary team, with functions that could include management of activities and projects; communication and propagation; scheduling management, support and attendance in each visit, feedback collection and cleaning of the lab. There are multiple ways of having some financial return or appreciation: collecting a fee or a caution or having a system of social economy. It was unanimous between interviews the importance of evaluation and feedback collection, in informal conversations with staff, an evaluation form, testimonials collection or internal staff meetings. In this topic, it is also important to talk about the insurance, the importance of having it or not, or even the communication of the existence to increase comfort and decrease fear of the users. It was also referred to the importance of documenting to guarantee printed support for each piece of equipment through FAQ's (Frequently Asked Questions) or a video.

Investing on networking and constant cooperation's, marking partnerships.

- Get an available team, that facilitates processes and focused on solutions, without fear of failure.
- Get some inspiration from successful projects for the design of yours, including seeing what is on the market in Portugal and abroad.
- Put yourself in the users 'shoes and try to understand what they value, so that your response is based on that value.
- Give special importance to communication, what is not communicated is not value.

Service Design

Next, it will be presented the design of a service for sharing MiniOpenLab lab, in which the resources of it will be shared with a community of users, with the aim of promoting STEAM areas associated with the sustainable development of youth and child. With that in mind, this service is a differentiator in the way that it was designed to a collective user – a community that needs to be created and dynamized across time. In an initial phase, this community will be the Scholé community itself, with perspectives of being extended to other schools and communities in general, in the future.

Community' Services

Designing for a collective user has different challenges associated. The first one is the understanding for what type of collective user the service is being designed for. The topic of communities is being discussed in these recent times (Chan & Zhang, 2020), and the concept of communities and the difference between network and communities needs to be clarified to understand why this service is being designed for communities and what are the impacts (Laís de Oliveira, 2020).

In the table 1 is presented an understanding of advantages and implications of a network and a community-designed designed service. A community assumes that the members will connect and create relationships of trust between them, creating more value as a community than individually. A network is a group of people that is sharing use of something (service, device, physical or virtual space).

The implications presented in Community column were considered during the build of service navigation and explained with detail.

Table 1 - Advantages and implications of a network of design a service for a network or a community

	Network	Community
Advantages	Creation process is simpler. When the experience is positive, users can be promoters and contribute to the network expansion.	The community itself could serve as an anchor and potent the sustainability of the service through a better retention of members and its expansion. Relationships of trust and the sharing of ideas and experiences that are being created could be perceived, per se, as a proposal of value with power of retention.
Implications	Relationship with the service can turn too much instrumental and loose strength after the excitement of experimentation phase. It's assumed the creation of a strong dynamic for the people to keep interest in use the lab.	Higher investment of time and energy by the owners in the creation of relationships of proximity and trust between members, somethings that requires an ongoing innervation across the time. The service will have to be design predicting that assumption and potentiating interaction between users. The host should have an aggregating profile to facilitate creation of relationships.

Personas

In the designing of the service, and according to Miaskiewicz (2011), it is also important to having in mind the users of the service. To facilitate that process 4 personas were created and presented above (Miaskiewicz & Kozar, 2011).

The first personas represent the students, children, and youth, there name is Maria and João. **Maria,** represented in figure 7, is a student, has 9 years old and studies in Scholé. She likes animals, watching animation programs in TV and has a concern about science environment problems because Scholé program has recently included a theme about oceans conservation. Her goal is having opportunities of hand-on experiences with her parents and apply the concepts that she is learning in Scholé. For her, convince her parents to spend some weekend time in MiniOpenLab space could be a problem. In that space, she is also worried about not having opportunity to use the equipment, since the space is small, and she imagines that a lot of people will use the space at the same time.

Figure 7 - Persona 1: Maria.

João, represented in figure 8, is also a Scholé student, and he has 8 years old. He likes any type of sports, he likes music and he even plays a musical instrument. He only goes to MiniOpenLab because her parents said so, and that is why he is struggling with gain motivation to continue to visit it.

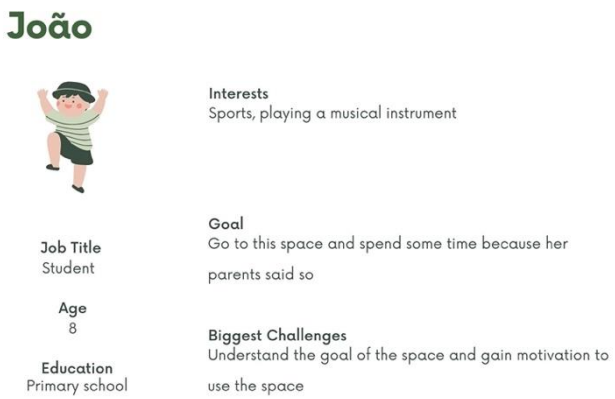

Figure 8 - Persona nº2: João.

Two personas for parents were also created to represent MiniOpenLab users.

Joana, represented in figure 9, is a 40-year-old professor, has a degree related with science areas and she likes themes related with her job, literature and everything that could be related with the school programming for their children. Visit MiniOpenLab is a way of performing activities with their children that are a complement to their educational program. However, she is worried about not knowing how to use the equipment of the lab, even more because she knows that the equipment is expensive. For the same reason, she is concerned with the value that the lab could charge for each visit because the trip to the lab is a cost, so the hole activity could have a high cost.

Figure 9 - Persona nº3: Joana.

Pedro, represented in figure 10, is a tech guy, a 35-year-old engineer that is always interest about leaning new technologies, all that is related with STEAM areas is a plus, and he likes to know more in the education field to give her children the education possible nowadays. He is interest in visit MiniOpenLab because her children are motivated to do it and are talking how cool could be visit the space and it is new activity to do with them. He already heard about fab labs so he is concerned about which equipment is available on the lab and if could be a queue to use the equipment he wants and visit time be spent on that. The time is also a concern, if the time that the lab is open is a match to his agenda and if it is enough.

Figure 10 - Persona nº4: Pedro.

Recommendations based on Phase I and Phase II results

After phase I and phase II, it was possible to create some categories based on the results of phase I and phase II to help clarify some main topics that the service should include, with each category replies to a question associated to them and present some recommendations and options to the owner of the service.

- Purpose and target – Who do we do this for?
- Marketing and access – How people will get to know us?
- Shared resources and procedures – What and how will we share? And What are the steps that user must do?
- Activities and program – Why will we share it?
- Time management – How will we manage time?
- Space management – How will we manage space?
- Staff and resources – What resources we need?
- Training and support – How to support users?
- Financial sustainability – How to make the space financially sustainable?
- Community management – How to manage MiniOpenLab community?
- Evaluation and feedback – How to know if we are doing a good work?

This service is designed to **share equipment and resources** of the MiniOpenLab, but also the knowledge of the host; users must have access to support during the design phase, transforming ideas in a project and help during use of the equipment. The service is being designed for students, parents, and educators of Scholé, and a community will also be an incentive to be developed. This community can **access this service through different channels**: telephone, email, and website; it is recommended the creation of campaigns and thematic workshops and choose a channel that can provide more support (time and tools) to clarify doubts quickly. The user can follow four steps to use the service: access – marketing campaigns, thematic workshops and communication channels, design – help identify the project, support in creativity and innovation; sharing – guarantying training before the visit, support during holidays; and the follow-up – during prototypes and re-design and collecting feedback.

This service is being designed to give the opportunity to the community to have access to equipment that are not available otherwise, complementing with the sense of community helping with multidisciplinary and critical sense. It is suggested that some thematic workshops and activities can be created related with educational program.

To manage time, the **creation of slots of time** it is important, for users to schedule and reserve the equipment they will need in each visit; guarantying what equipment each person will use to avoid waiting lines. To **manage space**, the suggestions are created defined areas and use decoration to identify areas and equipment and share the organization of the space with the users before the visit. The service will need resources, a multidisciplinary team as staff, with functions including activities/project management, communication and marketing, schedule management, training, and support during visit, collect feedback, cleaning the space, but also resources for each equipment. The staff or host should have another function, help manage the expectations and indicate the resources that each project will need. There are different ways of supporting users, with documentation about how equipment work, decoration of the space with identification of equipment, training as a requirement for using machines. One of the concerns is how to make the space financially sustainable, some methods can be: charge for a fee, for the resources used, convert a fee on credits to use or payment of a caution. The insurance should also be discussing, having one and communicate that to the users.

The development of a MiniOpenLab community is a priority and it is important that the service guarantee and encourage communication and interaction between users, for that a panel could be created to spread projects that are being made in the space, to inspire and motivate users.

In the end, it is important to understand if a good work is being done, trough evaluation and collection of feedback, ways to do it are informal conversations between users and staff, internal staff meetings to share it, add post-its next to each equipment for the users to share tips and evaluation forms and testimonials collection.

User journey

To apply all recommendations from Phase I and Phase II and having in mind the personas created for the users, ideally, the user type is a parent and a student, it was used User Journey and Service Navigation as Service Design Tools.

The customer journey, in this case, user journey, expresses the stages that a user can have when interacting with the service (Stickdorn et al., 2017; Teixeira et al., 2012). A user has a journey with 4 stages: the awareness or discovery is the first moment that user acknowledge that the service exists; the call to action is the second stage and describes the first interaction between the service and the user, it could happen trough a campaign, an invite to an workshop or word of mouth of an existing user; when the user accepts the call to action and visit the lab it starts to feel engage with the service and the community associated to the lab and the ideal journey is finished with the user spreading that message and value of the service around the MiniOpenLab, the very important word of mouth so that another user journey could start.

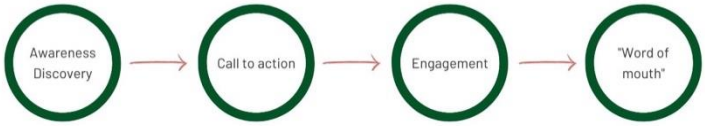

Figure 11 - User journey for MiniOpenLab.

Service Navigation

The service navigation is a graphical representation of how the service should work (Patrício et al., 2011). The service has two different moments that represents the different ways that a user could use the MiniOpenLab, the user can sign-up for a thematic workshop or reserve a slot of the time where the lab is open to receive users and use the space itself to engineering an idea.

The service navigation representation includes the activities performed by users or staff or both in the MiniOpenLab space, and it's divided in 3 phases: the registration, the visit, and the check-out. Under each activity is also represented the feelings that is predicted that the user experience (Stickdorn et al., 2017).

Workshop Service

The service of participate in a workshop on MiniOpenLab is represented in figure 10 and it starts with the user demonstrating some interest in visit the MiniOpenLab, **registering** in the workshop by confirming the presence with an email. Then, the staff of MiniOpenLab will **share the rules and a space's map**, the user is curious about how the space will work, the staff will clarify any doubts remaining, this is a way of keep the user's curiosity and on the other hand, give some autonomy to the user when visiting the space for the first time. The **thematic activity** will be happening, with a defined and previous communicated purpose, but the main goal of these workshops is to endow the users with basic knowledge about how to use the equipment in the lab, a major concern shared by parents in the focus group. In the same way, the staff will give **support** during the workshop to all users, guaranteeing the achievement of the learning process and increase of the safety and trust feeling, empower users to an autonomous usage of the space. To guarantee the financial sustainability of the service, the user will proceed to a **payment** activity at the end of the workshop, it is predicted that this activity can be associated to a sense of gratitude in the user (and not associated to the famous pain of paying). To close the circle, is important to **communicate future events and workshops**, inviting the users to the next call to action and restarting both of MiniOpenLab services.

Designing for communities' services in Workshop service

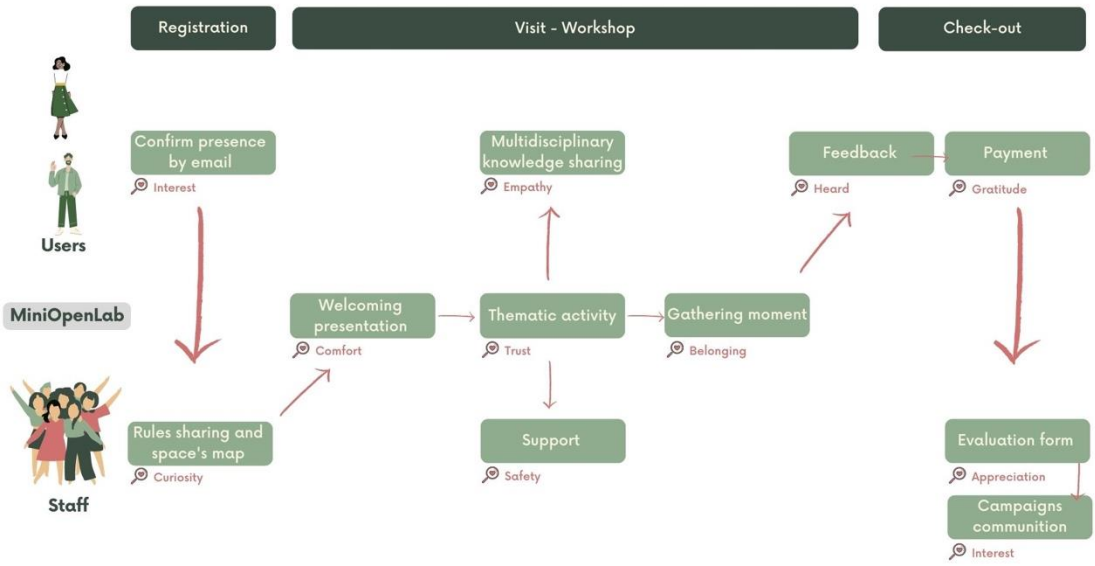

Figure 12 - Service Navigation for Workshop in MiniOpenLab.

This workshop' service is being designed for a community, or with the purpose of create, maintain, and retain this community. The communication is a key strategy to engage users in the community, and there are 4 important types of communication: communicate to inspire and sensitize; guarantee functional communication to enable users; social communication to reinforce the relationship and informal communication to clarify the impact of the community.

To retain the community is important to create distinctiveness, challenges (instigate competitiveness, evolution, and collaboration) and friendly environment. The creation of rituals to celebrate achievements and shares is important, as well as the feeling of belonging and the face-to-face contact (Laís de Oliveira, 2020; Richard Millington, 2013).

The creation of this workshop service is itself a functional communication, a way of enable users to understand and user with more confidence the equipment of the lab. The **welcome presentation** is a social communication, an activity for the users to know each other, get more comfortable, and a ritual to share and to create a friendly environment. During the thematic activity of the workshop, the users will **share knowledge** between themselves, this multidisciplinary is a desired effect of the user's interest, it creates a bonding effected, shares empathy and is a communication that can inspire the users.

The **gathering moment** is another ritual to celebrate the achievement of the workshop purpose by all users, reinforming the friendly environment and the sense of belonging. The activity of **feedback** before payment is important for the user to feel heard, keeping face-to-face contact and creating trustfully relationships between staff and the users.

Open Space Service

For the open space service, represented in figure 11, one of the key activitiy is the **reservation**. To create a good experience for all the users it is important to manage well the time and the space, as recommended above. In the stage of reservation, is important for the user to reserve a specific time and to clarify what is the equipment that will be used, for the staff to create a queue based on all reservations and avoid waiting times. In this activity, is also important to guarantee that the users to perform reservations in this service have already training session or a workshop completed. To guarantee a functional communication, the **rules and space's map** will be shared by the staff and all user's doubts will be clarified. During the **queue for using equipment**, and to match the concerns of the user shared in the focus group, the staff will guarantee **support** during a design phase, helping understand what the ideas of each user are and how to convert them into prototypes, and also support during the execution of them and the use of any lab equipment. To guarantee the financial sustainability of the service, the user will proceed to a **payment** activity at the end of the workshop, it is predicted that this activity can be associated to a sense of gratitude in the user (and not the famous pain of payment). To close the circle, is important to **communicate future events and workshops**, inviting the users to the next call to action and restarting both of MiniOpenLab services.

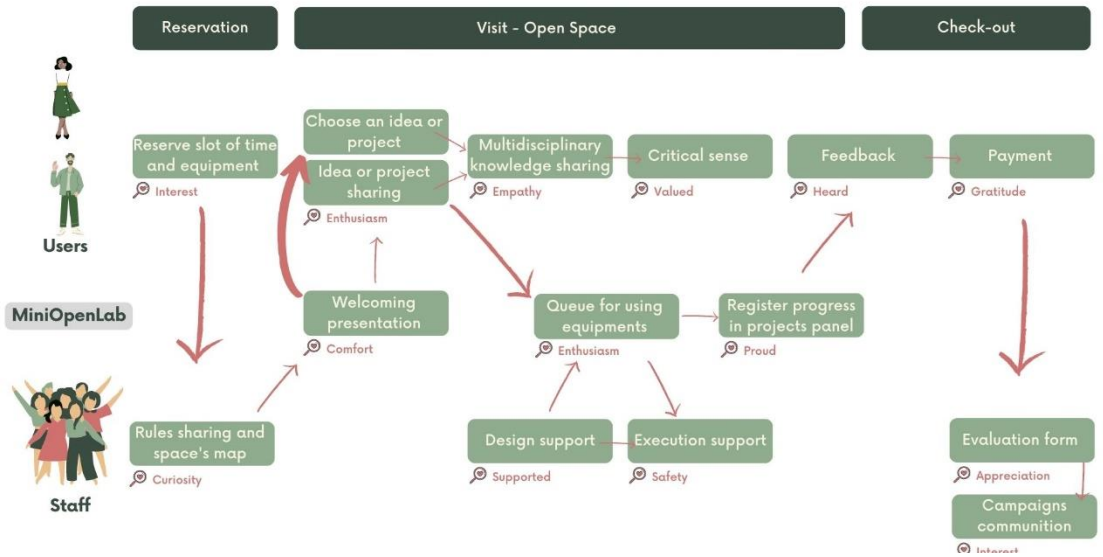

Figure 13 - Service Navigation for Open Space in MiniOpenLab.

Designing for communities' services in Open Space service

As mentioned above, the **welcome presentation** is a social communication, an activity for the users to know each other, get more comfortable, and a ritual to share and to create a friendly environment. But for this service; and as an introduction to design support, multidisciplinary knowledge sharing and critical support activities; an activity to **share ideas or project** was added to incentive inspirational and informal communication. This activity, for users using the service multiple times can be a check-up moment, to communicate the evolution of idea or project since the last visit, clarifying the impact of the community in that idea. In parallel, for the user to choose the preferable one, there is also an activity to **choose ideas or project**. This could work when the users don't have any idea but want to use the lab to build things and have a contribution to the external community, a backlog of needs of the external community could exists for users to choose ideas to create products/solutions for them.

During the thematic activity of the workshop, the users will **share knowledge** between themselves, this multidisciplinary knowledge being shared is a desired effect of the user's interest, it creates a bonding effected, shares empathy and is a communication that can inspiring the users. The **critical sense** is another desired effect, the user that shares feedback will feel valued, and the user that is receiving feedback will feel that their idea or project is being valued, so it is a win-win situation, enable the projects to evolve faster. To create another ritual of sharing and celebrating, it was suggested the creation of a **panel to register the progress** of each project. This activity is about informal communication and give the users the opportunity to communicate the experience: the support and feedback received and showing the importance and contribution of the community, but also a way to retain the community because this activity will also create some challenging and competitiveness because all projects will want to evolve the most in the panel. This panel could also be used to enable a voting session, creating some categories and elect winners. Once more, the activity of **feedback** before payment is important for the user to feel heard, keeping face-to-face contact and creating trustfully relationships between staff and the users.

Phase III – Prototype Phase

To conclude, is important to materialize solutions into prototypes, through an iterative process (Patrício et al., 2011). This phase was important to understand what is making a difference and needs to be amplified and what could be improved.

To prototype, a workshop was made for parents and students. The aim of the workshop was teaching about 3D printing and for that to build a keychain; and the theme was "Protect the oceans". In the workshop, 4 parents and 6 children participated, with the support of 4 members of the staff. The event was audio and video recorded, and some photographs are presented in figure 12. A script was suggested to the organization of a standard workshop, and is presented in Appendix E.

During the workshop, parents and children formed pairs. It was used a software to the design of the keychain that the children were already familiarized with that technology. In the end, the final design was download as a file and transfer to the 3D printer. One hour was not enough time to print all the designs, the printer started to print one of them, and the rest would be delivered a week after.

Figure 14 - Photographs of the workshop at MiniOpenLab.

The feedback about this workshop will be divided in positive aspects to amplified, aspects to improve in the next events and insights to have into account regarding the service.

The positive aspects to amplified are the way parents and children are received, in a welcoming and warm way, with snacks and beverages because food can be aggregator and a started for users to know each other.

Some aspects to improve in the next events are the welcoming and framework speech at the beginning in a way of inspiring and aggregating to potentially create relations between users in a community logic. Is also important a better dimensioning of the staff elements to be present in the first phase where users are not autonomous – users needed more attention. The physical evidence was lacked, there were just one sign for the used machine in the workshop, but the users asked for the other equipment in the room so is important to create an identification for the other equipment of the lab. The enthusiasm was visible in the beginning of the workshop, but at mid time was possible to notice that it was decreasing. This last note should be better perceived to add a middle activity, or a coffee/bio break could make the enthusiasm rise again.

Some aspects to consider are the printing time: the users cannot see the work made in the same day, so it is important to clarify expectations since de beginning to avoid frustration feeling. Some parents, when were pick up the kids to school at the end of the day showed some interest in using the space but also in doing something home and just print it there; so, it could make some sense, especially after a pandemic, to create a service for this need, with online learning, 3D printing of the designed product and delivery of the same.

6 Conclusion and future research

MiniOpenLab is a small laboratory, available at Scholé, and created in the context of ERASMUS+ project to diffuse STEAM education and ESD. This space is open to the local community and is an opportunity to children engage in STEAM-based projects on sustainable development. This dissertation intended to contribute to this project with the design of a community' service to be implemented at the MiniOpenLab, but more in detail with the key success factors for a sharing service on a school context and the design requirements that should be considered in services for communities.

It was possible to conclude that some of the requirements for the design of community' services are:

- The inclusion of engagement strategies for the community. The main strategy for the engagement of the community is the communication. Is important to include activities, in the service navigation, that promote communication that inspires and enables users and members of this communities, but also communication that reinforces relationships between members and clarifies the impact that the community can have. Some examples of this are the added activities as: welcome presentation, multidisciplinary knowledge sharing and the gathering moment.
- The inclusion of retainer strategies for the community. Is also important to, after creating, the service is designed to retain the community, and for that is important to create distinctiveness and promote a challenging and friendly environment. The creation of rituals to share and celebrate moments is also important, as well as the sense of belonging and the face-to-face contact. Some examples of this are the added activities as: idea/project sharing or choose idea/project, critical sense and register progress in project panel.
- Maintain consistence in language. For a community, is important to maintain the same language across all moments of interaction between the service and users and the members of the community.

From this dissertation, it was also possible to identify some key success factors for the design of future sharing services, especially for a school context:

- The existence of a community. Having a community is important for sharing services' users because the development of relations between the members of the community increases the level of trust between them, which is an important factor for the users of these kind of services.
- Guarantee support. Another important factor for the users of sharing services is the level of support, especially in these services where the level of investment in the equipment that is sharing is huge. The creation of a team to offer support across all moments of the service is important for the users to use and trust in the sharing service.
- Intrinsic motivation. For the users, it is important that children develop an intrinsic motivation to use the space because their motivation is the trigger for parents' motivation. For parents, the contribution for the external community is another source of intrinsic motivation to use the sharing service in this school context. It is possible to conclude that techniques like gamification will not be a driver in the case of this service because that is not the most important, there is a huge focus from both type of users of an intrinsic motivation, which is associated to deeper connection and longer duration.

For future research, is it recommended more investigation related with sharing economy and sharing of resources to understand better why people use these sharing services and what could retract people from using them. These valuable insights need to be applied during design of sharing services.

The tendency is for these concepts to evolve from sharing the use to sharing the ownership of resources. This evolution could be reinforced with the growing of sustainable development and sustainability concerns. These kind of knowledge about services that shares use and/or ownership could be applied to other contexts besides school context, for example, mobility. More than share the use of a car, it could be useful, in a sustainability perspective, to share the ownership of it. And to achieve services that share the ownership of resources, a community is important to increase the trust between the users and members of the community enough to enable this ownership sharing service.

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Appendix A – Script for Focus Group with students

Max 45min and in the MiniOpenlab

Introduction

Hello kids, do you know why we are here today?

Here at Scholé, a very special space will open and I really need your help to understand the best way to organize it.

Heating: Did you already know this room? Do you know what it's for? What do you think will happen here?

Questions:

1. Let's start by talking about a subject that you may have heard about, but I would like to know what you think about it – what is being **sustainable**? Who starts?
2. **At home,** do you talk about being **sustainable**? An example of something they have done at home to be more sustainable….
3. Did you know that **mathematics, science, and technology** help solving problems related to sustainability? Does anyone want to give an **example**?
   (Show images of the activities presented at the end of the script and ask to separate them by any order – the point that students can separate the ones associated with STEAM areas and the others that are not.)
4. Who would like to **do these activities**? And why?
5. Show video using 3D printer. **Would you like to come here with your parents and siblings?**
6. **How would it be**? Do you think your parents and teachers would like it?
7. And your **educators?**
8. What would you like to build here? *(See how it evolves and suggest sustainability)*

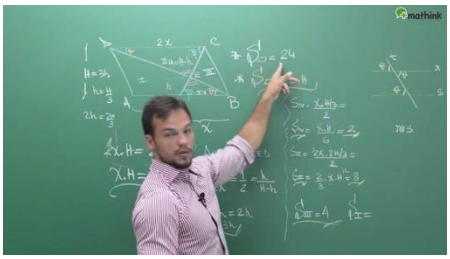
Acknowledgment and next steps

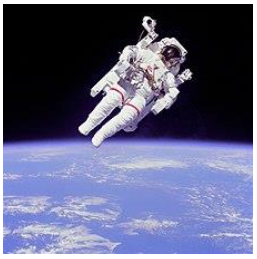
So now that I know your opinions, I'll try to think of a way for you to be able to come to this space with your parents and educators and know what kind of activities you can do with them. You will then come here to learn and play with them and then, you will try to tell me how it was.

Images of activities used in Focus Group with students

Activities not associated with STEAM

Activities associated with STEAM





TERMO DE CONSENTIMENTO

Caro Participante,

Venho por este meio solicitar a participação do seu educando num estudo de investigação que decorre no âmbito do Mestrado de Engenharia de Serviços e Gestão da Faculdade de Engenharia da Universidade do Porto. O objetivo da investigação é perceber o que poderá contribuir para a criação de um serviço de partilha de recursos do laboratório MiniOpenLab para o desenvolvimento e divulgação das áreas STEAM e sustentabilidade.

A participação do seu educando neste trabalho é fundamental. Neste sentido gostaria de formalizar o seu consentimento para a participação do seu educando num focus group, cujos resultados serão devidamente integrados na investigação. As respostas dadas serão estritamente confidenciais, e poderá desistir da atividade a qualquer momento uma vez que a sua participação é voluntária.

Tendo em conta que o focus group será gravado, peço o seu consentimento para a gravação de áudio da mesma, uma vez que facilita o trabalho de transcrição da atividade. No final de todo o trabalho de investigação, todo o material gravado será destruído a fim de preservar o anonimato e confidencialidade do material.

Atenciosamente,

Marta Faria up202001763

Matosinhos, _____ de _____ de 2022

Nome educando: _____

Assinatura do Encarregado de Educação: _____

Appendix B - Script for Focus Group with parents

Max. 45min and at MiniOpenLab

Introduction

Thank you for accepting this invitation. My name is Marta, I'm 26 years old and I'm from Guimarães. I'm also finishing my Services and Management Engineering master's at FEUP.

This focus group is part of my master's thesis, from the MESG at FEUP. It is part of an ERAMUS+ project in which Scholé participates together with the support of CEiiA. The aim of this project is to promote STEAM and sustainable development in children's education.

STEAM represents the areas of science, technology, engineering, art, and mathematics. With this project we want to raise awareness, to you as parents, to teachers but above all to your children, on how important it is to start, from an early age, to learn and be interested in STEAM areas, the importance of sustainability and how these areas can help. Also, there are few children who choose these study areas and, as such, one of our objectives is to inspire them to consider these areas as possible educational and professional paths.

For this purpose, we created a laboratory called MiniOpenLab. We can think of this space as a tool that parents and teachers can use to promote and wake up children's interest in these study areas. This space was equipped with various equipment and materials where STEAM areas can be put into practice, and where parents and educators can be active participants and users, together with children in an autonomous way.

Questions:

1. Do you feel that **STEAM** and sustainability are priority topics in education?
2. (If yes), have you had the opportunity to **actively work in these areas** with your children or, is it something you feel like they should only learn in school?
3. Regarding **sustainability**, do you work on this topic at home? How? **Do you have any sustainability practice at home**? Which one and how?
4. In terms of sustainability, we have heard a lot about the social or sharing economy. Do you often use sharing services? If yes, which ones? Would you be available to **share your car, toys or even clothes (example:** when you don't need it, you give it away, and when you need it, you receive it)?
5. What drives you to share and what holds you back in sharing services? As explained earlier, here we are going to create a sharing service in the context of the Lab. Can you imagine going to **this type of space with your children**? What would lead you to consider visiting this **space open to the community**? Can you imagine yourself using this space?
6. What are the biggest **fears and concerns** when using such a space?
7. What do we have to ensure so that they feel **comfortable** while in MiniOpenLab?
8. Would it be important to have someone here to **guide** you? What kind of **profile** should this person have? What do you expect from this host?
9. How would you like this **service to work**? (Silence and only then proceed with more surgical questions)

Imagine that next Saturday you want to use this lab – what would be the easiest and safest procedure? Would you book the service through an app, call, what would be easier for them to access this service?

Thanks, and next steps

Thank you all for your presence, collaboration and for sharing your experiences and opinions. This focus group is part of the exploration phase in which we want to collect opinions and suggestions from the potential MiniOpenLab's users. This phase is crucial for us to design a service that meets your expectations as much as possible.

TERMO DE CONSENTIMENTO

Caro Participante,

Venho por este meio solicitar a Sua participação num estudo de investigação que decorre no âmbito do Mestrado de Engenharia de Serviços e Gestão da Faculdade de Engenharia da Universidade do Porto. O objetivo da investigação é perceber o que poderá contribuir para a criação de um serviço de partilha de recursos do laboratório MiniOpenLab para o desenvolvimento e divulgação das áreas STEAM e sustentabilidade.

A sua participação neste trabalho é fundamental. Neste sentido gostaria de formalizar o seu consentimento para a sua participação num focus group, cujos resultados serão devidamente integrados na investigação. As respostas por si dadas serão estritamente confidenciais, e poderá desistir da atividade a qualquer momento uma vez que a sua participação é voluntária.

Tendo em conta que o focus group será gravado, peço o seu consentimento para a gravação de áudio da mesma, uma vez que facilita o trabalho de transcrição da atividade. No final de todo o trabalho de investigação, todo o material gravado será destruído a fim de preservar o anonimato e confidencialidade do material.

Atenciosamente,

Marta Faria up202001763

Matosinhos, _____ de _____ de 2022

Nome voluntário: _____

Assinatura: _____

Appendix C – Script for Interviews with Managers of Shared Resources Spaces

Max 45min and online

Introduction

Thank you for accepting this invitation. My name is Marta, I'm 26 years old and I'm from Guimarães. I'm also finishing my Services and Management Engineering master's at FEUP.

This focus group is part of my master's thesis, from the MESG at FEUP. It is part of an ERAMUS+ project in which Scholé participates together with the support of CEiiA. The aim of this project is to promote STEAM and sustainable development in children's education.

STEAM represents the areas of science, technology, engineering, art, and mathematics. With this project we want to raise awareness, to you as parents, to teachers but above all to your children, on how important it is to start, from an early age, to learn and be interested in STEAM areas, the importance of sustainability and how these areas can help. Also, there are few children who choose these study areas and, as such, one of our objectives is to inspire them to consider these areas as possible educational and professional paths.

For this purpose, we created a laboratory called MiniOpenLab. We can think of this space as a tool that parents and teachers can use to promote and wake up children's interest in these study areas. This space was equipped with various equipment and materials where STEAM areas can be put into practice, and where parents and educators can be active participants and users, together with children in an autonomous way.

As a space for sharing resources, we want to design a service so that users can use it autonomously and feel comfortable while doing so. For this, we would like to know your experience and perform a benchmarking.

Questions:

1. How did your project start? What was the basic purpose?
2. Who does your service target?
3. Who manages the space? Who composes your staff? Which different roles are there in your staff?
4. How do you publicize the service?
5. How is the engagement to your service? Have you noticed any increase?
6. What challenges did you have in capturing and retaining users?
7. How does your space work? Which processes and procedures exist to structure the service? Which service's support tools are there? Which are the formal and informal communication channels?
8. Do you evaluate the service? If yes, how?
9. How do you rate your service? Do users have that possibility?
10. And as for the feedback you get, what do you do with it?
11. What was the most challenging event in terms of operations and management?
12. How has the service evolved?
13. What recommendations can you give to our service, which is also shared and open to the community, to work in the best way? Which tips can you provide to a project that is now starting?

Acknowledgments and next steps

Thank you very much for your contribution. This interview was part of the exploration phase when we understand users' knowledge and perception in this context. Next, will be the ideation phase, in which we will design the operation of the sharing service for the lab. Once the master thesis is concluded, I will be happy to share with you the main conclusions.

TERMO DE CONSENTIMENTO

Caro Participante,

Venho por este meio solicitar a sua participação num estudo de investigação que decorre no âmbito do Mestrado de Engenharia de Serviços e Gestão da Faculdade de Engenharia da Universidade do Porto. O objetivo da investigação é perceber o que poderá contribuir para a criação de um serviço de partilha de recursos do laboratório MiniOpenLab para o desenvolvimento e divulgação das áreas STEAM e sustentabilidade.

A sua participação neste trabalho é fundamental. Neste sentido gostaria de formalizar o seu consentimento para a sua participação numa entrevista, cujos resultados serão devidamente integrados na investigação. As respostas por si dadas serão estritamente confidenciais, e poderá desistir da entrevista a qualquer momento uma vez que a sua participação é voluntária.

Tendo em conta que a entrevista será gravada, peço o seu consentimento para a gravação de áudio e/ou vídeo da mesma, uma vez que facilita o trabalho de transcrição da entrevista. No final de todo o trabalho de investigação, todo o material gravado será destruído a fim de preservar o anonimato e confidencialidade do material.

Atenciosamente,

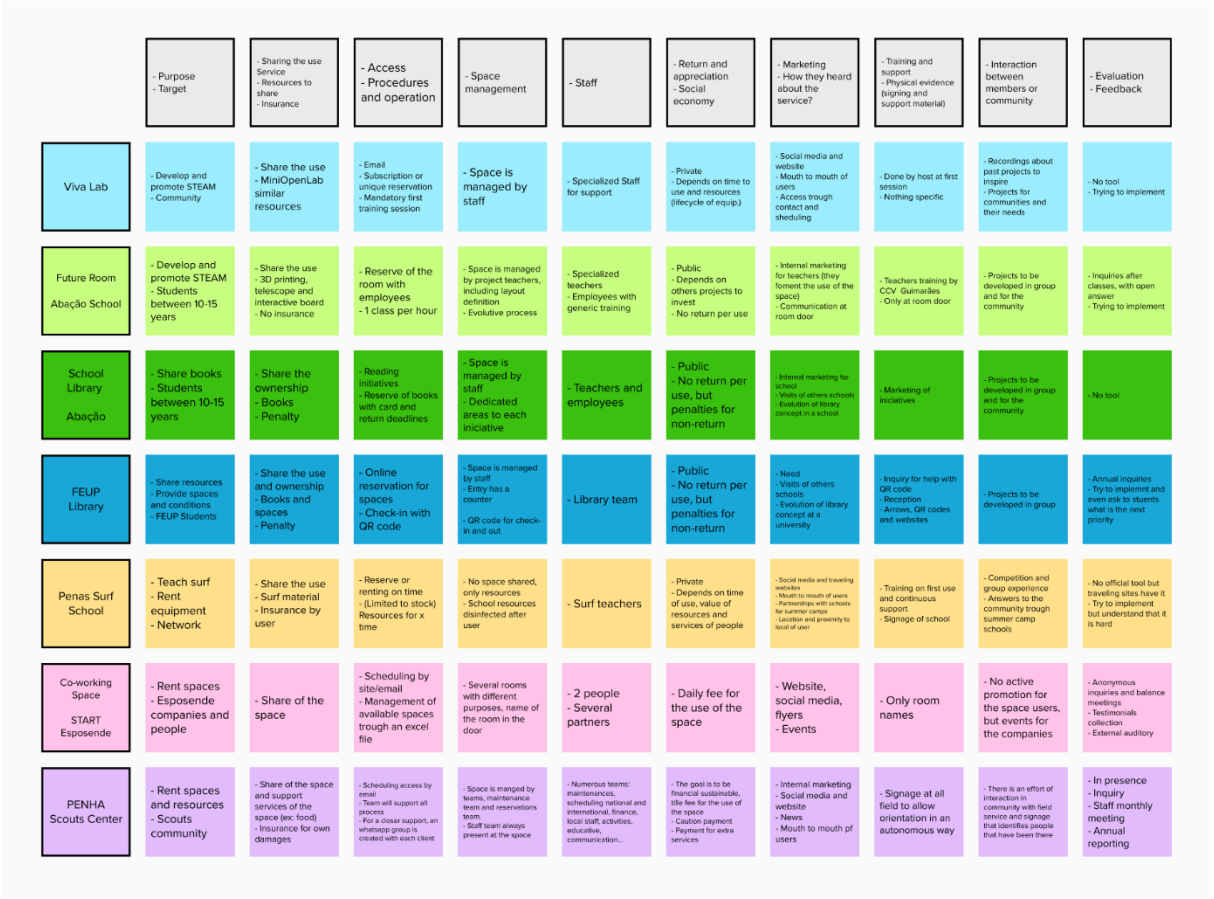
Marta Faria up202001763

Matosinhos, _____ de _____ de 2022

Nome voluntário: _____

Assinatura: _____

Appendix D – Benchmarking mural board



	- Purpose - Target	- Sharing the use Service - Resources to share - Insurance	- Access - Procedures and operation	- Space management	- Staff	- Return and appreciation - Social economy	- Marketing - How they heard about the service?	- Training and support - Physical evidence (signing and support material)	- Interaction between members or community	- Evaluation - Feedback
Viva Lab	- Develop and promote STEAM - Community	- Share the use - MiniOpenLab similar resources	- Email - Subscription or unique reservation - Mandatory first training session	- Space is managed by staff	- Specialized Staff for support	- Private - Depends on time to use and resources (lifecycle of equip.)	- Social media and website - Mouth to mouth of users - Access trough contact and sheduling	- Done by host at first session - Nothing specific	- Recordings about past projects to inspire - Projects for communities and their needs	- No tool - Trying to implement
Future Room Abação School	- Develop and promote STEAM - Students between 10-15 years	- Share the use - 3D printing, telescope and interactive board - No insurance	- Reserve of the room with employees - 1 class per hour	- Space is managed by project teachers, including layout definition - Evolutive process	- Specialized teachers - Employees with generic training	- Public - Depends on others projects to invest - No return per use	- Internal marketing for teachers (they foment the use of the space) - Communication at room door	- Teachers training by CCV. Guimarães - Only at room door	- Projects to be developed in group and for the community	- Inquiries after classes, with open answer - Trying to implement
School Library Abação	- Share books - Students between 10-15 years	- Share the ownership - Books - Penalty	- Reading initiatives - Reserve of books with card and return deadlines	- Space is managed by staff - Dedicated areas to each iniciative	- Teachers and employees	- Public - No return per use, but penalties for non-return	- Internal marketing for school - Visits of others schools - Evolution of library concept in a school	- Marketing of iniciatives	- Projects to be developed in group and for the community	- No tool
FEUP Library	- Share resources - Provide spaces and conditions - FEUP Students	- Share the use and ownership - Books and spaces - Penalty	- Online reservation for spaces - Check-in with QR code	- Space is managed by staff - Entry has a counter - QR code for check-in and out	- Library team	- Public - No return per use, but penalties for non-return	- Need - Visits of others schools - Evolution of library concept at a university	- Inquiry for help with QR code - Reception - Arrows, QR codes and websites	- Projects to be developed in group	- Annual inquiries - Try to implemnt and even ask to stuents what is the next priority
Penas Surf School	- Teach surf - Rent equipment - Network	- Share the use - Surf material - Insurance by user	- Reserve or renting on time - (Limited to stock) Resources for x time	- No space shared, only resources - School resources disinfected after user	- Surf teachers	- Private - Depends on time of use, value of resources and services of people	- Social media and traveling websites - Mouth to mouth of users - Partnerships with schools for summer camps - Location and proximity to local of user	- Training on first use and continuous support - Signage of school	- Competition and group experience - Answers to the community trough summer camp schools	- No official tool but traveling sites have it - Try to implement but understand that it is hard
Co-working Space START Esposende	- Rent spaces - Esposende companies and people	- Share of the space	- Scheduling by site/email - Management of available spaces trough an excel file	- Several rooms with different purposes, name of the room in the door	- 2 people - Several partners	- Daily fee for the use of the space	- Website, social media, flyers - Events	- Only room names	- No active promotion for the space users, but events for the companies	- Anonymous inquiries and balance meetings - Testimonials collection - External auditory
PENHA Scouts Center	- Rent spaces and resources - Scouts community	- Share of the space and support services of the space (ex: food) - Insurance for own damages	- Scheduling access by email - Team will support all process - For a closer support, an whatsapp group is created with each client	- Space is manged by teams, maintenance team and reservations team. - Staff team always present at the space	- Numerous teams: maintenances, scheduling, national and international, finance, local staff, activities, educative, communication...	- The goal is to be financial sustainable, tille fee for the use of the space - Caution payment - Payment for extra services	- Internal marketing - Social media and website - News - Mouth to mouth pf users	- Signage at all field to allow orientation in an autonomous way	- There is an effort of interaction in community with field service and signage that identifies people that have been there	- In presence - Inquiry - Staff monthly meeting - Annual reporting

Appendix E – Script for Workshop (suggestion)

Max 60min and in MiniOpenLab

1. Welcoming and framework about prototyping a service
2. Remember purpose of MiniOpenLab
3. Explain how the session will work (pairs between parents and children, mutual support between all)
4. Presentation of challenge/activity that will perform together
5. Following sessions by staff (clarifying doubts, share some tips…)
6. Presentation of the work by each group (taking a polaroid photo to post in the wall mural)
7. Acknowledgment and final message
   Example: "We are counting that you can be mobilizers of this communities, in a way that more children could have this opportunity of experimenting and enthusiasm for technology.