A reflexive analysis of participants' engagement in the co-design of digital resources

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Statement of Contribution

DOCTORAL PROGRAM IN INFORMATION AND COMMUNICATION TECHNOLOGY

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Mercedes Huertas-Migueláñez

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1. List of publications

This thesis reports work that has been mainly done by the author as part of her doctoral studies. Part of the work presented in chapter **??** has been published as follows:

Giunchiglia, Fausto, et al. "Crowdsourcing a Large-Scale Multilingual Lexico-Semantic Resource." The Third AAAI Conference on Human Computation and Crowdsourcing (HCOMP-15), San Diego, CA. 2015.

Huertas-Migueláñez, Mercedes, Natascia Leonardi, and Fausto Giunchiglia. "Building a Lexico-Semantic Resource Collaboratively." The XVIII EURALEX International Congress. 2018.

2. Research/study activities

During the first half of my PhD I was part of a Marie Curie Initial Training Network (FP7-PEOPLE-2013-ITN) in the ESSENCE project. A European project founded by the European Comission (G.A. 607062). The project aimed at investigate the evolution and negotiation of meaning among human and artificial agents.

During the second half of my PhD I was awarded with a Erasmus Mundus scholarship that allowed me to spend six months in KixLab at Korea Advance Institute of Science and Technology (KAIST). I collaborated with other PhD fellows and professors in designing and conducting studies, and preparing papers.

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Then I would like to thank my committee for kindly reviewing my work providing insightful comments and directions that have helped me to improve the previous version of this manuscript. Thanks to everyone who took part in the studies conducted during this thesis: for their patience, energy, and dedication. Thanks to my colleagues in the KnowDive research group for their support during the difficult times. Thanks to my colleagues in the InterAction Lab and Social Informatics group for sharing your experiences and knowledge with me. I would also like to thank the researchers and students I met during my stay in South Korea. Thanks for your curiosity and exciting research. Many thanks to Marie Skłodowska-Curie ITN and Erasmus Mundus for having funded this work. Thanks to my Marie Skłodowska-Curie fellows for making group work a fun experience.

Many thanks to my old friends and all those friends I met during my nomadic years. Thanks for sharing your time and experiences with me to remind me that there is life beyond academia. Special thanks to my family for their unconditional support, for listening to me, and for encouraging me in the moments of despair to finish this adventure.

Abstract

Appealing participants' engagement drives collaborative systems to enhance it through system's use or through system's design. However, engaging participants in collaborative systems to create digital resources is not trivial to achieve as the majority of contributions are provided by a very small percentage of engaged participants. In the literature, different approaches, such as human-in-the-loop and co-design, investigate engagement in these lines. This thesis aims to study how reflexivity can help designers to investigate participants' engagement in co-design of collaborative systems. Based on a qualitative approach, the thesis is positioned in the field of Human Computer Interaction and grounded on two studies.

The retrospective analysis of the two studies was guided through a framework composed of three phases. In the first phase, supported by the literature review, several qualitative methods were investigated to identify the communities to be involved in the research; in the second phase, different co-design sessions were conducted with participants; and in the third phase, participants evaluated the solutions co-designed.

The two studies followed different but intertwined approaches. Study 1 followed a user-centric approach and supported the identification and consolidation of a set of factors that hindered or facilitated engagement. The factors were articulated as barriers, drivers, and workarounds, and were validated in Study 2, which followed a participative approach. These factors constitute the first contribution of this thesis. Moreover, the literature review and the empirical data supported the identification of three dimensions to facilitate the adoption of a reflexive approach in co-design. These dimensions correspond to the second contribution of this thesis. Finally, the set of barriers, drivers, and workarounds was merged with the dimensions to propose a framework to investigate engagement in co-design of collaborative systems, constituting the third contribution of this thesis.

Keywords: qualitative research, engagement, reflexivity, co-design, engagement in use, engagement in design

Contents

Introduction

This introductory chapter describes the motivation of this work followed by the research questions that drove the research presented here. It then presents the two studies, concluding with the outline of the thesis.

1.1 Motivation

Engagement is a desired feature in systems aimed at ensuring participation and contribution to collaborative approaches. In this thesis engagement refers to *engagement in the design*, the commitment people feel when taking part in a design project they have been involved in, and *engagement in use*, the motivation which drives the users in the interaction with a system. In this case, engagement refers to the psychological state needed to foster human contribution to computing systems, specifically in the form of data, as well as to the psychological state of being immersed in the interaction associated to specific interface features.

Distinct fields investigate engagement in different but intertwined ways and in all of them, engagement is identified as a process that changes according to the interaction and involvement of participants in a design project (O'Brien and Toms, 2008) (Østergaard et al., 2018).

In the literature, eliciting participants' engagement has been investigated through their contribution and immersion during use in fields such as collective intelligence (Malone et al., 2009), human computation (Law and Ahn, 2011), crowdsourcing (Howe, 2008), and social computing (Parameswaran and Whinston, 2007). Moreover, increasing *engagement in use* has been investigated through user experience (UX) where different design elements aimed at enhancing engagement have been researched (O'Brien and Toms, 2008). Hence, engagement, in this case, is technology-mediated. Furthermore, recent research indicates that softer skills such as self-control or focus may be of influence for the completion of tasks (Ren, 2016).

Engagement in design has been researched through participants' involvement in design activities, mainly in co-design (Sanders and Stappers, 2008) and participatory design (PD) (Simonsen and Robertson, 2012), where engagement is mediated

through the co-creation of artefacts such as probes, toolkits, and prototypes (Sanders and Stappers, 2008) (Sanders and Stappers (2014)). Research on engagement in design involves the study of more complex aspects where relationships and technologies as well as users and how they influence the engagement process has also been investigated. More precisely, in the field of PD two approaches that investigate engagement are reflection and reflexivity. On the one hand, reflection focuses on the design practices and urges designers to think about the design process focusing on the relationships between users, technologies, and settings as a way to analyse and evaluate new technologies (Karasti and Blomberg, 2012) (Sengers et al., 2005). On the other hand, reflexivity considers relationships, personal expectations, feelings, and commitments in the design setting among all participants. It refers to all forms of participation that emerge during the design process as well as their evolution, where intuition, judgement, and communication skills are required to perceive and translate interaction in context (Pihkala and Karasti, 2013). Furthermore, according to Salehzadeh Niksirat et al. (2018), feelings are hardly ever acknowledged in research although designers know it is an important driver of the design activities as well as an essential aspect of participants' engagement.

Moreover, motivation is an important aspect that influences *engagement in use* (O'Brien and Toms, 2008) as well as *engagement in design* (Light and Akama, 2012). By harnessing participants' cognitive and perceptual human skills, engagement can be investigated through intrinsic and extrinsic motivation (Ryan and Deci, 2000b).

However, participant engagement through active contribution and participation is hard to achieve in those collaborative systems aimed at co-creating digital resources. Even the most successful systems, such as Wikipedia, which has become the main information source for many Internet users, suffers from limited contribution. It has been reported that some 2.5% of Wikipedia users contributed to around 85% of the content and 50% of it has been generated by 1% of the contributors (Rafaeli and Ariel, 2008). This means that a small percentage of engaged participants contribute with the majority of content. Engagement is a pivotal aspect in this type of systems to tackle problems such as resource incompleteness and maintenance (Bond and Foster, 2013) as well as to keep the required quality standards (Kirov et al., 2016). This thesis adopted a different orientation and examined engagement in the co-design of collaborative systems from a reflexive perspective, where reflexivity provided a more introspective way to understand engagement among all participants involved in the co-design process.

In this thesis, co-design considered two different approaches, one with a focus on user involvement in which researchers and designers move toward users, as in usability testing, and another in which users move toward researchers and designers, as in PD (Steen, 2013). The two studies reported in this thesis are located at the two

approaches described by Steen (2013). Study 1 is a user-centered design case where participants were involved as informants (Iivari and Iivari, 2011) and the feedback provided was used to redesign a user interface (UI). Study 2 is a participatory approach where participants were involved in a more 'hand-on' role (Iivari and Iivari, 2011) taking part in the co-design of a digital resource. Moreover, in both studies, engagement was studied from a retrospective point of view, when the data collection had already finished.

1.2 Research questions and contributions

This thesis bases its work on the reflexive analysis of engagement in co-design. This is not trivial to achieve, and with the aim of understanding how these approaches merge in practice, this thesis investigated engagement through a retrospective reflection on two different studies through the following research questions:

RQ1: How can reflexivity help designers to investigate participant's engagement in co-design of collaborative systems?

This question was addressed through investigating engagement in two co-design projects. The first one followed a traditional user-centred design and aimed at co-creating a linguistic resource. The second one aimed at co-creating an online repository to share and store teaching materials exploiting participatory processes. To guide the research of this thesis, this question is divided in two sub-questions:

RQ2: What can facilitate or hinder engagement in co-design of collaborative systems?

RQ3: What factors facilitate the adoption of a reflexive orientation in co-design?

For each of the questions, the answer represents one of the contributions listed below (Figure 1.1).

- RQ2 was answered by articulating a set of barriers, drivers, and workarounds to engagement in co-design. Barriers correspond to those factors that hindered engagement, drivers correspond to those factors that facilitated engagement, and workarounds correspond to strategies adopted to facilitate participants' engagement during the co-design process when they encounter factors that hinder their engagement. Workarounds depend on the context around which
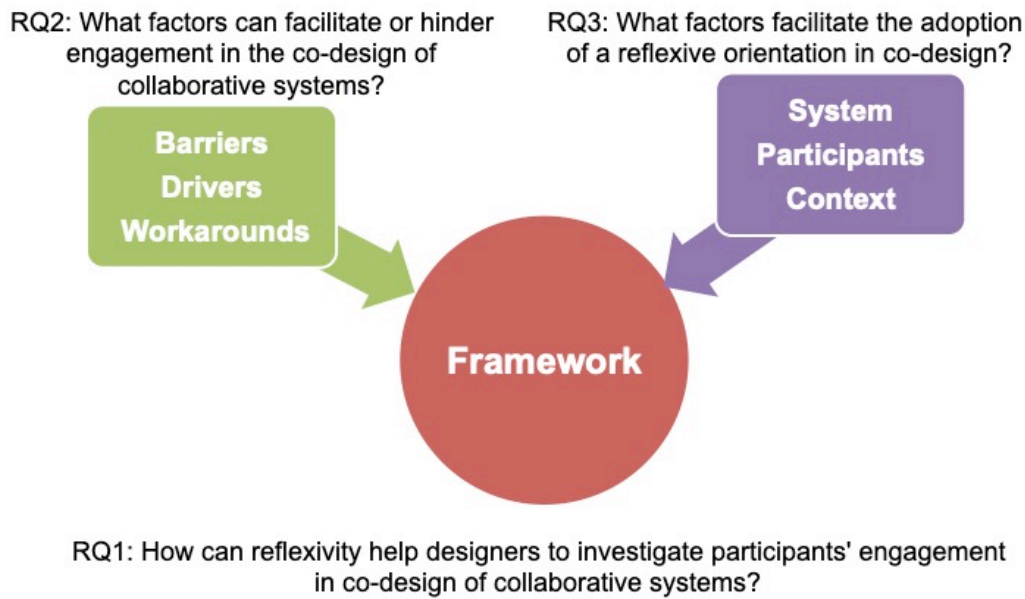
Figure 1.1: contributions of the thesis

they emerge as well as on the participants involved. This set serves as an orientation for similar systems.

- RQ3 was answered by defining three dimensions that guide the adoption of reflexivity in co-design. These three dimensions support the understanding of relationships, commitments, personal expectations, and feelings facilitating the adoption of a reflexive approach throughout the design process in three main areas: the system, which refers to the co-designed artefact around which participants' engagement is instrumented; the the participants, which refers also to the participants and the researcher as a participant; and the context, which refers to the social context in which co-design is taking place.

- RQ1 was answered by defining a framework to investigate engagement in co-design. The framework is motivated by the interest in investigating engagement understood in two different approaches: *engagement in the design* and *engagement in use*. It is based on the empirical work described in this thesis and the comparison with the literature on co-design, UX, and motivation. The framework identifies and articulates elements that are characteristic in the investigation of engagement in co-design processes and it is the result of merging the set of barriers, drivers, and workarounds, that answered RQ2, with the set of dimensions, that answered RQ3. Each of the dimensions is composed of questions clustered in themes according to specific aspects observed during the retrospective analyses of the two studies and guide the reflexive process.

The framework is intended to be a generative tool for researchers, designers, and practitioners in the design of systems to investigate engagement.

1.3 Studies

The work presented in this thesis is based on two studies. In the first one, participants were involved in the co-design of a collaborative system that aims at the co-creation of a linguistic resource. In the second one, participants are involved in the co-design of a collaborative system to share teaching resources. Both cases were grounded on the same issue, engaging participants, and are further described as follows.

Study 1

In this study the collaborative system under study represented a UI aimed at collecting contributions to co-create a linguistic resource. Following a human computation approach (Law and Ahn, 2011), the system involved experts and semi-experts who contributed by translating words from English into Italian. Moreover, participants were involved in the co-design and validation of the UI that facilitated translations and evaluation of such translations. In this study, participants engaged were professors and students from Linguistics departments in two different universities. The initial aim of the data collected was to improve the design of the UI. However, the retrospective analysis aimed to identify the factors that hinder or facilitate engagement following a reflexive orientation. This analysis reflected on the notion of *engagement in use* as it reflected on participants' contribution and their immersion while using the UI. Moreover, the analyses was guided by the framework described by Steen, 2013 to identify and consolidate those factors and articulate them into a set of barriers, drivers, and workarounds.

Study 2

This study aims at co-designing a repository to store and share educational materials. The study involved primary school teachers that enhance sharing, and support other teachers through the creation of a tangible and a digital archive to keep and share the materials created through the academic year. After years of storage and lack of classification, navigation through all the materials was a challenging task. Teachers were in need of a common classification strategy as well as a common place to store and access their materials. The initial aim of the data collected was to support

teachers in the creation of a common classification of teaching materials as well as the creation of a repository. However, the retrospective analyses aimed to validate the set of barriers, drivers, and workarounds to engagement following the framework proposed by Steen, 2013. This analysis reflected on the notion of *engagement in design* as it reflected on participants' commitment to the project.

1.4 Thesis outline

This thesis is structured in seven chapters (Figure 1.2).
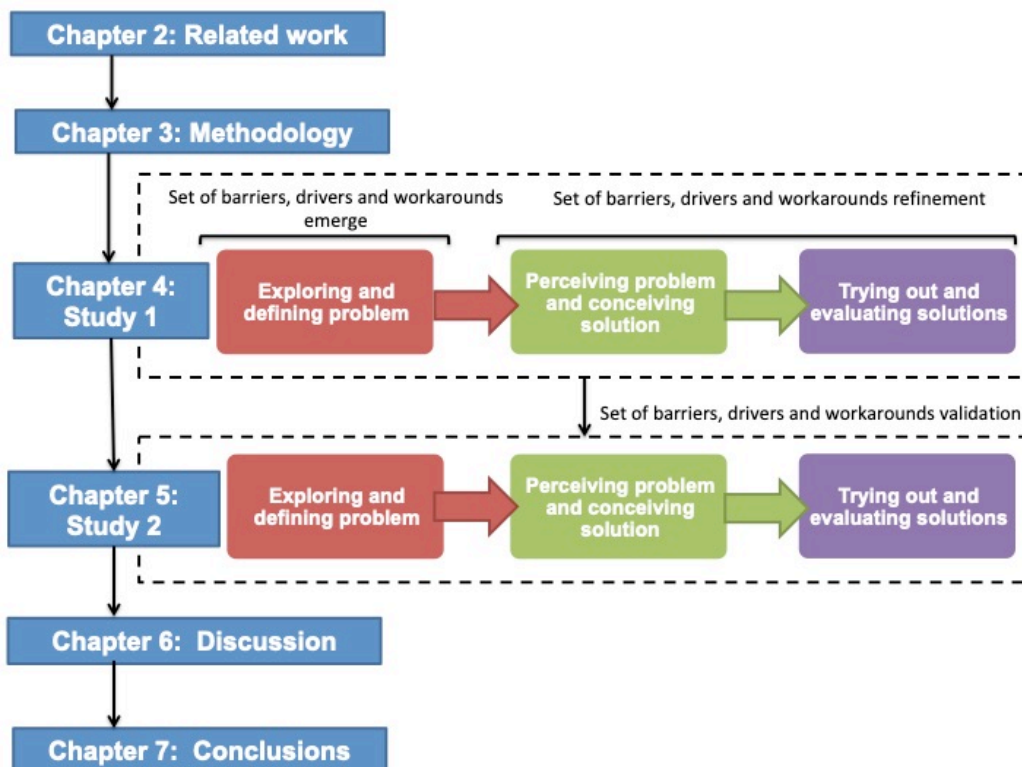
Figure 1.2: Research process followed in the thesis

Chapter 2 introduces the theoretical foundations of this thesis. This chapter starts by analysing the human-in-the-loop and how humans have been involved in solving tasks that computers can not do appealing to participants' *engagement in use* where UX is analysed as an approach to enhance engagement. It then reviews co-design as an approach to investigate *engagement in design* introducing the concepts of reflection and reflexivity to investigate engagement. A review on motivation, as common variable for both approaches to engagement, concludes the chapter.

Chapter 3 introduces the methodology and places this work within the qualitative research field. Next it describes the research process of the thesis inspired by Steen (2013), who divided the co-design process into three steps: exploration and problem

definition; perceiving problem and conceiving solution; trying out and evaluating solutions. After this, the reflexive orientation of the thesis is described, followed by the methods to collect and analyse data that conclude the chapter.

Chapter 4 describes the retrospective analysis of the data collected in Study 1 by following the framework adopted (Steen, 2013). In the first phase, community was identified through an exploratory study that involved students and a professor of linguistics. Moreover, an initial set of factors that hinder or facilitate engagement emerged articulated as barriers, drivers, and workarounds. This set was refined in the next two phases by involving participants in the evaluation of a paper prototype, in a focus group and in a real-life testing. The result of this study was a refined set of barriers, drivers, and workarounds to engagement.

Chapter 5 aims at validating the set of barriers, drivers, and workarounds by retrospectively analysing the data collected in Study 2 following the framework proposed by Steen (2013). The first phase focused on i) the identification of the community through observations and interviews with primary school teachers, and ii) the definition of the problem through several studies, such as a focus group, a prototype evaluation and a round of informal interviews. Once the community was identified and the problem defined, the research moved to the next phase, where a co-design workshop was conducted. Lastly, the result of the co-design workshops was evaluated by the participants. The result of this study corresponded to a validated set of barriers, drivers, and workarounds to engagement.

Chapter 6 discusses how the work presented in this thesis has answered the research questions presented at the beginning. It also describes the contribution of the thesis to the field of engagement in the co-design of collaborative systems.

Chapter 7 elaborates on the lessons learnt throughout the research process, the limitations and suggests directions for future work.

Related Work

2

The literature presented in this chapter starts by analysing the human-in-the-loop and how humans have been involved in solving tasks that computers can not do appealing to participants' *engagement in use* where UX is analysed as an approach to enhance engagement. It then reviews co-design as an approach to investigate *engagement in design* introducing the concepts of reflection and reflexivity to investigate engagement. A review on motivation, as common variable for both types of engagement, concludes the chapter.

2.1 Human-in-the-Loop

The concept of human-in-the-loop was first introduced in artificial intelligence (AI) to increase the contribution of people with data. Humans were involved in those tasks where their expertise and their skills outperform computers. Some of those tasks are visual perception, optimisation or supervision (Scott et al., 2002).

One of the most prominent research areas that has involved humans in the loop is AI. The increase in computational power and the availability of massive amounts of data has led to an improvement in areas such as natural language processing (NLP) or machine learning (ML), whose algorithms are usually provided and supervised by a human operator (Holmquist, 2017) who evaluates the quality of data collected (Siorpaes and Simperl, 2010); controls the correct functioning of the algorithm; and provides data required by the algorithm (Bella et al., 2016). Therefore, humans are required in those tasks that cannot be automated, or at least, that cannot rely on automation alone, such as the creation of Linguistic content where the human is required to contribute information which is not available to computers. Linguistic resources are lexical databases to use under programme control. These resources are important for machine-understood tasks, such as NLP and ML; to guarantee the presence of a language in the information society; and to learn and understand linguistic relations between language elements.

Furthermore, in AI, the result of an algorithm depends on two factors: i) the statistical approach employed to obtain conclusions and ii) the quality or quantity of data. AI algorithms learn according to the set of data used to teach them (Vincent,

2016). Data sets can be collected from human activity, such as online navigation, or provided by human input through human computation systems. Different approaches have appealed for *engagement in use* to involve humans in computational tasks, such as the co-creation of digital resources. Collective intelligence was defined by Malone et al. (2009) as "*groups of individuals doing things collectively that seem intelligent*". In the paradigm of collective intelligence, computational tasks are performed by human beings and the result of a process depends on the collaboration of the participants (Quinn and Bederson (2011)). According to Quinn and Bederson (2011), collective intelligence also embraces other approaches that appeal for *engagement in use,* such as crowdsourcing, human computation and social computing.

2.1.1 Human computation

Human computation was defined by Law and Ahn (2011) as "*the intelligent systems that explicitly organize human efforts to carry out the process of computation*". Human computation is an approach that engages people in solving tasks that computers cannot do (Schall et al., 2011) and whose outcome is used to train AI systems. In a similar way to human computation, in crowdsourcing people can substitute traditional human or machine tasks. However, whereas in human computation humans replace machines, in crowdsourcing workers are replaced by lay users (Quinn and Bederson, 2011). Moreover, when people are recruited following the traditional method, and not through a crowdsourcing site, the system can be considered a human computation system (Law and Ahn, 2011). Furthermore, those tasks that involve any creativity are not considered human computation as they do not pursue a computational aim (Quinn and Bederson, 2011). Several digital resources were developed through human computation in the past years. For example, Leake and Lewis (2016) created an educational resource by aggregating existing teaching resources created by school teachers. In the field of linguistics, small groups of lexicographers collaborated in the co-creation of linguistic resources. WordNet (Miller, 1995) was the first system to build a linguistic resource for computers. Composed of English nouns, verbs, adverbs and adjectives, the lemmas are organised in sets of synonymous words known as synsets. Despite the success of the project, due to a lack of funding its development stopped in 2006. Others translated English WordNet into different languages manually using corpora and bilingual dictionaries as well as monolingual dictionaries. Some of these examples are MultiwordNet (Pianta et al., 2002), BalkaNet (Tufis et al., 2004), MCR (Agirre et al., 2012) or EuroWordNet (Vossen, 2002). Another example is presented by Leake and Lewis (2016) who created an educational resource by aggregating existing teaching resources created by school teachers.

Moreover, resources developed following this approach, involve the (manual) development of digital resources being expensive in terms of human power required but highly valuable with respect to the quality of the resource produced (Bond and Foster, 2013).

Human computation and crowdsourcing have some points in common when the tasks can be completed indistinguishably by humans or computers. One of those tasks is translation. Translation can be completed either by a computer or by experts. The quality of the translations can vary according to the available texts and language pairs. For example, in (Hu et al., 2010) the authors proposed engaging monolingual speakers in the improvement of text translated using machine translation tools.

2.1.2 Crowdsourcing

The term *crowdsourcing* was first defined by Howe (2006) as "*Crowdsourcing is the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call.*" Crowdsourcing spread thanks to the internet and has been used extensively in many fields changing the way data is produced, and research conducted (Howe (2008)). Systems such as Amazon Mechanical Turk [1] or FigureEight [2] have facilitated the access of crowd users to millions of different tasks. Crowdsourcing has been used to populate linguistic databases where workers engage by adding new terms or by translating them, mainly from English, to other languages. Some linguistic resources have benefited from this approach and were built by the collaboration of large numbers of contributors, such as Wiktionary, an online free multilingual dictionary that is created and edited by volunteers, and contains words in 172 languages, although definitions are only in English (Meyer and Gurevych, 2012). Wikitionary is built by a large community of lay users that engage by adding new terms or by translating them from English to other languages (Meyer and Gurevych, 2012). Another example corresponds to YARN (Braslavski et al., 2014) that aims to create a thesaurus in Russian. They involved and paid 45 students to contribute to the creation of a thesaurus for Russian.

However, building digital resources such as linguistic resources through a crowdsourcing platform might not be a reliable approach, as crowd workers might rely on sources produced by faulty machine translation systems rather than producing them themselves (Hu et al., 2010). Moreover, Benjamin (2014) highlighted the high costs of paying experts to ensure the quality of the resources. Furthermore, other approaches select a mix of automatic and crowdsourcing methods to build lexical

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[1] https://www.mturk.com/
[2] https://www.figure-eight.com/

databases (Benjamin, 2014)(Chilton et al., 2013) where humans are required to label data and supervise the result of the automatic tasks.

2.1.3 Social computing

Social computing refers to those applications and services that allow online social interaction and collective action by engaging users in the co-production of digital knowledge (Parameswaran and Whinston, 2007). Technology mediates communication among different human actors fostering natural behaviour, which is the factor that differentiates it from human computation systems (Quinn and Bederson, 2011). Therefore, Wikitionary represents an example of social computing as it allows interactions among the contributors that are collaborating on the compilation of a page.

To sum up, this short review has identified the existence of several computational projects that aim to engage humans in use to provide data, performing tasks which cannot be solved automatically. The next section reviews UX as an approach to engage participants through the use of different design elements.

2.1.4 User experience (UX)

Engagement in UX has been described as the state of a user, a system or the interaction. However, as recently described by Doherty and Doherty (2018), when engagement is understood as a process it facilitates the analysis of its changes over time and interactions. Nonetheless, user engagement has been considered a sign of a well-designed system that aligns user subjective experience with the goal of the digital tool. However, it can also be the outcome of negative aspects such as technology distraction, lack of socialisation or addiction (Doherty and Doherty, 2018).

Different researchers have investigated *engagement in use* through different variables. For example, Webster and Ahuja (2006) considered engagement as a subset of flow (Csikszentmihalyi, 1997), dependent on focus, curiosity, and intrinsic interest in computer interaction. Webster and Ahuja (2006) tested engagement in three different versions of the same websites where 21 participants were observed and interviewed. For them, engagement is related to easy navigation, high level of performance, and intentions to use the web in the future. In this case, engagement is attained with a combination of factors including challenge and skill. Another

study that has considered flow as a dimension of engagement was conducted by Hart et al. (2012). In this study, engagement was measured as a compound of three variables: flow, affect, and involvement. Engagement was measured on three interactive websites with 40 participants by distributing a questionnaire. They found out that interaction and involvement have no effect on user engagement whereas affect, defined as a combination of emotion and mood, increases user engagement. Moreover, according to Hart et al. (2012), context and user characteristics on perceptions of engagement are also important.

Finally, O'Brien and Toms (2008) proposes a definition based on an extensive literature review on engagement and semistructured interviews of 21 participants in website testing. O'Brien and Toms (2008) defined user engagement informed by a theoretical framework where system attributes were combined with user characteristics. For O'Brien and Toms (2008) user engagement is "*a quality of user experiences with technology that is characterized by challenge, aesthetic and sensory appeal, feedback, novelty, interactivity, perceived control and time, awareness, motivation, interest, and affect.*". Moreover, user engagement is linked to user interaction dimensions such as "*challenge, affect, endurability, aesthetic and sensory appeal, attention, feedback, variety/novelty, perceived control, and interactivity*". Moreover, according to O'Brien and Toms (2008) *engagement in use* is a process composed of five stages.

- point of engagement, which refers to when the engagement process started

- a period of engagement. This period refers to the time that engagement lasts

- disengagement might happen due to the external or internal process that forced the cessation of being engaged and it might be associated with positive emotions, i.e. when the user's needs are covered, or to negative emotions, when the system stopped working

- returning to the system and the tasks for short or long term was identified as reengagement

- non-engagement, which might happen when participants do not engage due to a bad experience with the online system

Recently, Doherty and Doherty (2018) stated that online systems should support different levels of engagement, like those described by O'Brien and Toms (2008). Doherty and Doherty (2018) further stated that systems should facilitate the transition among them proposing strategies for engagement based on design directions such as ensuring usability, facilitation of immersion, supporting social connection, utilisation of reminders, allowing exploration and engaging the emotional response and

management of user's resources, such as cognitive load. Furthermore, O'Brien and Toms (2008) also identified the factors that hindered engagement, such as negative experience to emulate a real-life encounter, technology issues such as information overload and pop-ups, badly designed communication tools that delayed feedback, and interruption management. For them, feedback was an additional element for engagement as it allowed users to adjust the navigation in the online application, be aware of the functioning of the system, and communicate with it or with others. A final interesting remark that they added was that "*while an application may be usable, it may not be engaging, but engaging applications do appear to have an inherent baseline of usability.*".

Other studies that investigate *engagement in use* measure it based on the analyses of log files. For example, Dittus et al. (2016) identified the factors that influence the engagement of first-time contributors to large crowdsourcing platforms by defining a metric based on the time spent in the platform, independently of the quality of the contributions, and the number of first-time contributors that came back not only on the second day but also in the second and third month. Dittus et al. (2016) conducted a study for 18 months to understand first time contributors and, 180 days later, to study who, of those first time contributors, came back to the platform. They discovered that the factors for engagement were related to task coordination, the design of the tasks, and previous knowledge of the task. Other authors proposed measuring engagement through a survey. O'Brien and Toms (2010) interviewed 350 participants and used 109 scales to identify the six dimensions that formed *engagement in use*. These dimensions were validated through a questionnaire which was completed by 850 participants. The dimensions identified were Perceived Usability, Aesthetics, Focused Attention, Felt Involvement, Novelty, and Endurability, (Table 2.1). Furthermore, they found out that these dimensions are tightly related and have a strong influence on the whole UX.

Finally, *engagement in use* has been measured through a combination of observations, and interviews, such as in (Swift et al., 2010), where participants were engaged at diverse levels: i) individual, characterised by participant's immersion in the task; ii) unilateral, characterised by responsiveness to another user effects; and iii) bilateral, characterised by conscious interaction of two participants.

2.2 Co-design

In the design of interactive systems, adopting an approach where the participant is at the centre means involving users in the design process as well as during the evaluation and appropriation of the system designed, that is *engaging participants*

Dimension	Definition
Aesthetics	Engaging systems catch and captivate user interests, draw people in, and encourage interactions. These aspects are related to focused attention and involvement in aesthetic experiences. Moreover, multimedia users demonstrated strong preferences for visually based multimedia where aesthetic elements (i.e., illustrations) contributed to Web users' first impressions of a Website.
Focused attention and perceived usability	Focused Attention factor is defined by items pertaining to focused attention, awareness, and perceptions of time. These facets represent some, though not all, characteristics of Flow.
Endurability	Endurability is the assessment of users' perception of success with a task, and their willingness to use an application in future or recommend it to others.
Felt involvement and perceived usability	The Felt Involvement factor contained items about how much fun users were having during the interaction and how drawn in they were able to become. If the user has experienced Felt Involvement, it is because the usability of the system did not interrupt or prevent them from enjoying themselves; in this situation, judgments of the Perceived Usability will be influenced by the level of involvement achieved.
Novelty	Novelty in online content has the potential to sustain users' attention, specifically when novelty is introduced through links and content that are pertinent to users' goals.

Table 2.1: Definition of the attributes for engagement by O'Brien and Toms (2010)

in the design. Different approaches give voice to those who are affected by the change that a specific system will introduce. It will also encourage their active involvement through different means of participation that would engage them with the design space (Marti and Bannon, 2009). For example, Bratteteig and Verne (2018) claim that, when users can not influence the design choices, the possibilities to propose alternatives are reduced, revealing users' resilience as they have to adapt their practices to the way the system works.

In the literature, there are several approaches that place participants in the centre of the design process and advocate for their engagement through the design

of the systems that they would further use, such as co-design (Sanders and Stappers, 2008) and PD (Simonsen and Robertson, 2012). In this thesis I will investigate co-design and the opportunities it offers to engage participants in the design of collaborative systems to co-create digital resources.

Co-design is an instance of co-creation and refers to the creative expressions produced along the design process that involve designers and participants alike. Users are involved as co-designers, researchers as facilitators and designers will facilitate envisioning future contexts as experts in conceiving final products (Sanders and Stappers, 2008). Following this standpoint, Sanders and Stappers (2014) described the co-design process as composed of four phases:

- the pre-design phase, to understand people's experience in context and the initial involvement;

- a generative phase to produce ideas;

- evaluation of the effectiveness of the artifact designed;

- post-design to understand people's experience after the process.

Moreover, Steen (2013) identified the approaches that can be considered co-design and divided them into i) approaches with a focus on user engagement in which researchers and designers move toward users, as in usability testing, and ii) approaches in which users move toward researchers and designers, as in PD. Furthermore, Sanders and Stappers (2014) introduced the concept of 'making' as an activity that engages designers and co-designers in the process of co-design. For example, they suggest that the artifact being prototyped can be a vehicle to foster reflection, discussion and expression of future directions. They proposed three approaches to 'making':

- *toolkits* that are composed of artifacts to make objects and are specifically created for each project/domain.

- *prototypes* that are representations of a future object. Prototypes are physical manifestations of ideas or concepts. They can provide the overall idea only, or they can resemble the final result.

- *probes* that are objects designed to elicit a response.

According to (Pedersen, 2016) by understanding the power dynamics in context, designers and users would be engaged in the long-term throughout the co-design activities. Furthermore, Pedersen (2016) calls for more creativity and flexibility in the implementation of practices if co-designers want to engage heterogeneous participants in the design process. Engagement has a strong relationship with participation, which happens at different levels and in different ways, through workshops, meetings or interactions among people (Vines et al., 2013). According to Vines et al. (2013), researchers, who act as facilitators in the design process, initiate the engagement of users and share control of the design process with them. The levels at which participants engage in participatory processes are diverse and can fluctuate along the design process. Hence, Vines et al. (2013) proposes different modalities of participation namely, *witting, unwitting, when users participate in the design of new systems through unvoluntair actions, spectator-like as a reflexive commentator or creator the participation of others*. In this line, Vines et al. (2013) challenges researchers to "*be flexible in where to set the boundaries for participation so that the voices of those less likely to become involved are to be reached*". Moreover, Light (2010) proposes that before starting a participatory process, the different levels of interaction, at all levels, should be understood and how such levels interact. She described them as interpersonal and group dynamics, which will influence the initial engagement; the clear definition of the design space where the participatory process will take place; and the interrelations at all levels, between participants and people not involved in the participatory process. However, Light (2010) adds that in order to increase engagement in the participation process, researchers should pay attention to the relationship between designer-participants and its impact on the design process. This articulation is crucial for the result of the design and the participatory process. Similarly to Light (2010), Thinyane et al. (2018) propose researchers should be aware of the barriers and challenges that may arise during the process. Some of these can be language, cultural factors, knowledge of technology, power dynamics, and personality traits. Based on their experience in working with a community-based organisation, Thinyane et al. (2018) propose the corresponding mitigation measures for each of these barriers. Some of the measures proposed are using multilingual participants to help those with language problems; considering the context in which the project is being developed; the creation of a common agenda with all members; organisation of meetings in the participants settings as well as paying attention to participants' allocation in the participatory sessions; positive attitude towards technology and enthusiasm towards solution finding; and emphasis on group dynamics to avoid participants' isolation.

In this section, a summary of what co-design is, and implies, has been presented. Considering that co-design refers to "*envisioning possible futures*" and that it implies designers and practitioners sharing a common understanding of what needs to be done and how to better cooperate (Steen, 2013), in this thesis I want to reflect on

the co-design of collaborative systems to create digital resources, more precisely linguistic resources and educational resources, as co-design processes.

The next section reviews reflection and reflexivity as approaches to investigate engagement in the design of collaborative systems to co-create digital resources.

2.2.1   Reflection and Reflexivity

Several authors have elaborated on the notion of reflection as a method to *engage in the design* when in a participatory process (Dalsgaard and Halskov (2012)) (Bødker and Iversen (2002)). In 1983, Schön (1983) established the importance of reflection in practice by defining the concept of reflection-in-action. Reflection-in-action describes the sequence of feelings and actions researchers go through when an event does not go as expected. In unexpected situations, researchers reflect on the reasons that brought them to that situation and how they could redirect the situation while the action is developing. To do that, researchers build on previous experiences that would support their reflections on current unexpected situations, by articulating how previous experiences relate to the current one while, at the same time, considering the uniqueness of the current situation. When reflecting in action, practitioners inquire into the tasks, the methods and the procedures applied to accomplish them. On the one hand, practitioners are not passive recipients of researchers' reflections: they take an active role in the research process when they describe their ways of reflecting in action while developing their practices. On the other hand, researchers, through observation and intervention, can help practitioners to reflect when describing their own experiences. By observing engaged individuals we can understand how they react and relate to the task they engage with from a contextual point of view as well as from an affective and cognitive point of view.

Similar to Schön (1983), Bødker and Iversen (2002) distinguished two types of reflection: ongoing reflection and off-reflection elicited by "why" and "where-to" artefacts. On the one hand, designers use "why" artiefacts to represent why a specific solution is proposed, whereas the "where-to" artefacts would inform the direction of the design process. On the other hand, designers need to interpret, during the development of the design activities, what Schön (1983) identified as reflection-in-action. Designers reflect before and after design activities, based on previous experiences and introspection, making the designer think about the direction of the process.

Other authors have proposed conceptual tools or artefacts to elicit reflection. For example, Dalsgaard and Halskov (2012) propose a process for documenting the participatory process to facilitate reflection and identify what has changed, how,

and why, in order to provide better frameworks for solution as well as to contribute to the further understanding of the nature of design research. Moreover, it helped researchers to understand how the participation process should enhance the sense of community through knowledge sharing among members. Another approach proposed by Kraff (2018) involves a tool for collective reflection to understand participants' *engagement in the design* by acknowledging their diversity and their needs: different groups have different preconditions and they need to be involved in different ways. Thanks to the tool researchers could illustrate how groups were related to each other and how a movement of one group may affect another. However, involving participants in the participation process could enhance knowledge sharing. By acknowledging group diversity, researchers adapted their methods and decisions according to the participants' needs. These three tools represent three ways to elicit and facilitate reflection while considering the aim of the project where they were investigated. Whereas, in the first case, the artefacts try to make participants aware of the sense and direction of participation, the last two inform *engagement in the design* by acknowledging diversity, and the sense of community, through knowledge sharing.

Finally, while Schön (1983) articulates reflection-in-action as a method for designers to reflect on the design process under development, for Simonsen and Robertson (2012), PD theory advocates for collective reflection in action among the many participants of the participatory process. According to them, it is through workshops and collaborative activities that mutual learning is favoured. Moreover, it is in these activities that all participants involved can express their views on the current context and have a voice in the design of new technologies that will shape their future practices.

Furthermore, according to Karasti and Blomberg (2012), PD needs critical reflection to address the dynamics in the research and design processes: the critical observation of the evolution of the relationships among participants while involved in the research process. According to them, during critical reflection, researchers, as well as participants, are considered a whole. Furthermore, for Sengers et al. (2005) critical reflection is an essential part of design as it allows participants to make conscious choices that will affect their practices while, at the same time, it guarantees freedom and quality of life improvement. However, Karasti and Blomberg (2012), make a distinction between reflection inspired by Schön (1983) and reflexivity. On the one hand, reflection considers the relationships between users, technologies, and settings. On the other hand, reflexivity considers relationships, personal expectations, and commitments in the design setting. Therefore, reflexivity invites researchers to self-examine themselves, the others and their relationships (Weber, 2003). Hence, enacting reflexivity means being critical within the context of design while, at the same time, considering it as an opportunity to change practice (Pihkala and Karasti,

2016). Reflexivity happens during the research process and through articulation of practices and construction of knowledge: it helps in the analysis of research (Pillow, 2003) conveying a deeper consideration of the subjectivity (Day, 2012). Reflexivity situates the researcher socially and emotionally in relation to participants (Mauthner and Doucet, 2003). Reflexive research places its interest in studying relationships rather than focusing on techniques, technologies, and users as the "objects" to be researched (Karasti, 2010).

When analysing the design space reflexively by focusing on reflexivity to understand practices of design research, *reflexive engagement* proposes an orientation to engage researchers as well as participants in the design process. It refers to all the forms of participation that emerge during the design process, as well as their evolution, allowing participants to express their needs and interests, and designers to engage in the dynamics of participation while adapting their practices accordingly. *Reflexive engagement* involves the researcher as a participant questioning where participation is, and how to enhance it, in specific contexts of design (Pihkala and Karasti, 2013).

Moreover, when researchers act as facilitators, participants' *engagement in the design* and reflection in design activities would be enhanced (Light, 2010). For Light and Akama (2012), facilitators, similarly to the reflective practitioner (Schön, 1983), reflect on their practice and on the participatory process, making them more aware on how the situation is evolving. (Light and Akama, 2012) propose the concept of *'embodied knowledge'* and defines it as the knowledge acquired by facilitators when engaged in interactions, observations, and reflections on the context where the intervention is taking place. *'Embodied knowledge'* is based on participants' emotions, impressions, and dynamics, and it is crucial when engaging in design activities. Engaging participants means allowing them to be themselves, express themselves, and be immersed in the participatory process. That is known as quality of participation, which unfolds as *genuine participation* (Østergaard et al., 2018). This concept introduced by Simonsen and Robertson (2012) and Simonsen and Jensen (2016) was investigated by (Østergaard et al., 2018) who propose a conceptual framework to investigate the evolution of *engagement in the design* in the participatory practices towards genuine participation. In this framework, different degrees of participation can be understood as the different levels of engagement, what Pihkala and Karasti (2016) called "*participation in plural*" and defined as "*the many ways participants can be engaged with the design process and become a participant beyond pre-established roles and is entangled with the digital technologies, the practices, and the reflections*". Østergaard et al., 2018 propose the selection of a matter of interest for participants in order to understand the evolution of the *engagement in the design* while co-designing digital technologies. Østergaard et al., 2018 proposed looking at participating as themselves, participating with themselves,

and participating for the task of the project. For the first, participating as themselves, they reflected on the relevance of sharing experiences and knowledge with the rest of the participants, who are sharing the same context, while being aware of their own opinions. For the second, participating with themselves, they highlighted the relevance of common learning so that participants are able to *engage with the design process*. For the third, participating for the task of the project, they reflected on the fact that the participants rejected an initial design proposal offered by the researcher, realising that the project would only succeed if they engage and that it was their chance to have a digital artefact designed for, and by, them.

2.3 Motivation

Motivation is an important aspect of engagement. On the one hand, Webster and Ahuja (2006), and O'Brien and Toms (2008) included motivation as one of the variables to describe *engagement in use*. On the other hand, for Light and Akama (2012) motivation is embedded in the design process being the reason why people decide to propose a project, take part in it and come to an end together. Therefore, motivation is a common aspect of *engagement in use* and *engagement in design*.

Motivation is one of the key concepts used in psychology to explain and predict human behaviour. Research in this field is vast, and differs according to different theoretical frameworks. In this thesis, the key characteristics of motivation are reviewed. These characteristics have been used to conceptualise behaviour in human-computation tasks. In a nutshell, being motivated means to "*be moved to do something. A person who feels no impetus or inspiration to act is thus characterized as unmotivated, whereas someone who is energized or activated toward an end is considered motivated.*" (Ryan and Deci, 2000a). According to the self-determination theory (SDT) (Ryan and Deci, 2000b) a main distinction exists between intrinsic and extrinsic motivation. This distinction is based on the different reasons which motivate action and the goals associated with it. Intrinsic motivation fosters a behaviour that is "*inherently interesting or enjoyable*", whereas extrinsic motivation refers to "*doing something because it leads to a separable outcome*" (Ryan and Deci, 2000a).

Intrinsic motivation

Intrinsic motivation exists in individuals, as well as in relationships between individuals and activities, and it is the nexus between person and task: people are motivated for some tasks, and some people are motivated by other tasks. Focusing on tasks and

how they can enhance intrinsic motivation leads to better task design and increased motivation.

The cognitive evaluation theory (CET) (Deci and Ryan, 1985) specifies the conditions in social contexts that enhance intrinsic motivation. This theory proposes that intrinsically interesting challenges, the feeling of being capable of completing an action, or autonomy, can promote intrinsic motivation. Moreover, the theory adds that tangible rewards, deadlines, threats, and evaluations tend to undermine intrinsic motivation.

Ryan and Deci (2000a) proposed two main measures of intrinsic motivation: free choice, which refers to whether participants return to the activity without being requested to; and self-reports of interest and enjoyment in a task where people express what motivates them to contribute. The validity of the motives expressed by the participants in these reports, and the correlation with behaviour, was studied through the sixteen basic desires proposed by Reiss (2004). Reiss (2004) identified sixteen motives, related to an individual's behaviour, and the intrinsic feelings linked to them (Table 2.2). According to Reiss (2004) the motive Social contact is linked to the feeling of fun or the motive Curiosity is linked to the feeling of wonder.

Motive Name	Motive	Intrinsic Feeling
Power	Desire to influence	Efficacy
Curiosity	Desire for knowledge	Wonder
Independence	Desire to be autonomous	Freedom
Status	Desire for social standing	Self-importance
Social contact	Desire for peer companionship	Fun
Vengeance	Desire to get even	Vindication
Honor	Desire to obey a traditional moral code	Loyalty
Idealism	Desire to improve society	Compassion
Physical exercise	Desire to exercise muscles	Vitality
Romance	Desire for sex	Lust
Family	Desire to raise own children	Love
Order	Desire to organize	Stability
Eating	Desire to eat	Satiation
Acceptance	Desire for approval	Self-confidence
Tranquility	Desire to avoid anxiety, fear	Safe, relaxed
Saving	Desire to collect, value of frugality	Ownership

Table 2.2: Reiss's 16 motives

To elicit *engagement in use,* Law et al. (2016) appealed to the motive Curiosity, which, according to Reiss (2004), is linked to the desire for knowledge. Law et al.

(2016) designed a set of questions and clues to foster curiosity in participants who had to transcribe audio recordings. These clues guided and engaged contributors until the end of the task. Law et al. (2016) found out that, thanks to the clues, participants were engaged until the completion of tasks with a high number of right guesses. Another point highlighted by Reiss (2004) corresponds to the coexistence of desires or their manifestation at different times in different users. Rotman et al. (2012) conducted a study along these lines to observe the initial motives that drove people to collaborate online, and how those initial motives evolved to different ones. Rotman et al. (2012), however, used the scale proposed by Batson et al. (2002) who described four motivating factors for volunteers to take part in community projects (Table 2.3). Rotman et al. (2012) distributed a survey among 142 participants who were either volunteers providing data or scientist, who collected the data. Rotman et al. (2012) understood that the initial motivational factor corresponded to egoism whereas the secondary motives that engaged them were recognition and attribution, feedback, community involvement, advocacy, and altruism. Moreover, Rotman et al. (2012) identified two barriers to engagement. The first one refers to the lack trust between volunteers and scientist. The second one corresponded to motivational factors that were not addressed: attribution and recognition were important for volunteers whereas scientist, who had to acknowledge them, did not understand the importance of that recognition.

Motive	Description
egoism	to increase one's own welfare
altruism	to increase the welfare of one or more other individuals
collectivism	to increase the welfare of a group or collective
principlism	to uphold some moral principle

Table 2.3: Volunteers motives according to Batson et al. (2002)

In other piece of research, Clary et al. (1998) proposed six dimensions to classify volunteers' motivations (Table 2.4). This scale was investigated by Nov (2007) to correlate participants' intrinsic motivation to contribute to Wikipedia with *engagement in use*. Moreover, they defined what the motives are that have a positive correlation with higher contribution numbers, and therefore, engagement. *Engagement in use* was defined here as the number of hours spent contributing, A survey was distributed among 370 Wikipedia contributors, from which 151 people replied. Nov (2007) correlated the number of hours per week spent on the platform with the six dimensions extracted from the volunteering motivations scale by Clary et al. (1998) and added two further categories: Fun and Ideology defined as "*shared, relatively coherently interrelated sets of emotionally charged beliefs, values, and norms that bind some people together and help them make sense of their worlds.*". In this

study, Nov (2007) concluded that Fun has high correlation with motivation and high levels of contribution and, therefore, high engagement. However, Ideology and Social might not be related to high levels of contribution and, therefore, would lead to low levels of engagement.

Motive	Description
values	opportunity to altruistically contribute with knowledge to the community;
Understanding	opportunity to learn new things, improve knowledge and skills
Enhancement	opportunity to show own knowledge
Protective	opportunity to protect from negative feelings of oneself such as guilt for being more fortunate than others
Career	opportunity to keep skills up to date or gain some experience;
Social	opportunity to be with friends or do something that is viewed well by others

Table 2.4: Volunteers motives according to Clary et al. (1998)

Contrary to what was found by Nov (2007), in The Rosetta Foundation (TRF) translation project, Idealism played an important role in volunteers' motivation (O'Brien and Schäler, 2010). The Rosetta Foundation, currently known as Translators without Borders, aims at building a linguistic resource containing all languages of the world. O'Brien and Schäler (2010) conducted a study to understand what motivates people to volunteer for the TRF translation project. A survey was distributed among 257 volunteer translators registered in the project; 139 of them replied. The authors discovered that the higher rated motives were the support to TRF's cause, which is linked to Ideology, as well as gaining professional translation experience, which is linked to Understanding. The authors concluded that volunteers were motivated by personal goals and social causes.

In the studies presented on intrinsic motivation, different authors proposed alternative classifications of volunteers' motives. Reiss (2004) was selected here as the starting point to understand the classification of basic desires linked to intrinsic motives and individuals' behaviour identified by Batson et al. (2002) and Clary et al. (1998). These classifications have been used to understand participants' motives to contribute to online collaborative systems.

Incentives and gamification

Incentives relate to human emotions and play an important role in enhancing intrinsic motivation to ensure engagement, although their perception and effect

depends on the context (Scekic et al., 2015). One way to engage participants is by highlighting the importance of their contribution. For example, Beenen et al. (2004) applied two social theories' principles on two different groups of users in an online movie recommender system. The first principle applied was the collective effort model which identifies conditions under which people will socially contribute more by i) believing that their effort is important to the group's performance; ii) believing that their contributions to the group are identifiable; and iii) liking the group they are working with. The second principle investigated was that of high-challenge goals in an online community, by suggesting what level of performance the individual could be expected to attain. They found that having a clear challenging goal while being part of a community, increases the number of contributions. Moreover, the authors believe that integrating these findings with usability principles should increase the number of contributions.

In this line, Nov et al. (2013) proposed a different approach where designers used messages to state the aim of the online community participants were contributing to. For a period of 45 days, authors tracked the activity of 462 participants in an online community and recorded whether these participants were returning to the website. They discovered that stating the aim of the community proved to be useful to engage those participants who identified themselves with the communities' aim, whereas people who did not feel identified, abandoned it.

Another approach to engage participants corresponds to providing feedback upon task completion, which can have a positive effect on intrinsic motivation when it is not expected. However, it can have a negative effect when perceived as controlling (Deci et al., 1999). Regarding this, Kraut and Resnick (2011) specify that performance feedback is especially motivating because that makes people feel good and shows status. Moreover, positive feedback enhances motivation when it is considered sincere. Furthermore, feedback can be especially motivating for those who like competition. This type of feedback is included in many websites in the means of game elements. This technique is known as gamification. Gamification refers to the use of elements characteristic from games in non-game contexts and its aim is to increase *engagement in use* (Deterding et al., 2011). By using levels, points, leaderboards or badges users acknowledge their progress and this gets them engaged.

Different online services have used gamification strategies to engage users in the long-term. For example, Q&A sites such as StackOverflow[3], an on-line programming question and answer community, includes gamification elements to evaluate responses and to engage respondents. Users, who replied to questions, receive

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[3]`https://stackoverflow.com/`

badges provided by other users who vote positively on those answers. According to Cavusoglu et al. (2015) users feel more motivated to participate and more attached to the community, as a badge makes them feel connected to the community and makes them feel of value to the community. However, the result of gamification techniques on *engagement in use* varies not only depending on the activity but also on the user's motivation. Further understanding of the social environment, the nature of the system and how to engage users beyond cognitive involvement would benefit the understanding of contextual factors in projects where volunteer contribution is required (Hamari et al., 2014).

Extrinsic motivation

Extrinsic motivation refers to completing an activity for its instrumental value. In order to motivate people to complete tasks independently without external pressure, Ryan and Deci (2000a) defined the concepts of *internalisation* and *integration* of values and behaviour. *Internalisation* refers to the process of understanding the value of an activity whereas *integration* refers to the process by which individuals take an activity and adapt it to their own behaviours. Moreover, integration is described as a continuum that goes from amotivation, or lack of intention to contribute, to personal commitment. The organismic integration theory (OIT) describes the factors that facilitate or hinder internalisation and integration (Table 2.5).

Factor	Description
Amotivation	refers to the lack of interest or desire to act. It is the result of not valuing an activity, not feeling competent to do it, or not believing it will yield a desired outcome
External Regulation	refers to the satisfaction of a demand or to obtain a reward
Introjected regulation	refers to the performance of actions under pressure to avoid guilt, anxiety or to attain ego-enhancements or pride.
Identification	the person has identified with the personal importance of a behavior and has thus accepted its regulation as his or her own.
Integrated regulation	refers to the inclusion of an activity into the behaviours of a person that happens through identification of self-reflection and integration of new values and needs

Table 2.5: Factors that facilitate or hinder internalisation and integration according to Ryan and Deci (2000a)

Rewards

Rewards are provided as motivators to complete tasks and, therefore, keep participants *engaged in use*. In the literature, there are many types of rewards. The most common reward systems are described in (Scekic et al., 2013):

- Pay per performance, where people are compensated according to their contribution. It increases productivity when tasks are simple. Its application is mainly observed in crowdsourcing platforms such as Amazon Mechanical Turk.

- Bonus, where people get a bonus upon reaching a specific limit.

- Deferred compensation. Similarly to the previous one, people get compensations at specific points in time.

- Evaluation. People are evaluated with respect to other people, such as in competitions.

- Promotion. For people, the prospect of promotion increases motivation.

- Team compensation. This type of reward is provided when the contribution to a team is not clearly identifiable.

2.4 Conclusion

This chapter has reviewed two fields that have investigated the two approaches to engagement described in this thesis: human-in-the-loop, as an approach to *engagement in use*, and co-design, as an approach to *engagement in the design*.

The chapter started by analysing the human-in-the-loop and how humans have been involved in solving tasks that computers can not do appealing to participants' *engagement in use* through UX. Next, the chapter introduced co-design as an approach to investigate *engagement in design* and how reflection and reflexivity have been investigated to understand engagement. Finally, it describes motivation and its relevance for both *engagement in use* and *engagement in design*.

Methodology

3

The chapter starts by describing the research methodology adopted, positioning its work within qualitative research. This is followed by the research process that guided the analysis of the two studies. Next, it introduces reflexivity as an orientation to analyse data in the thesis. Finally, it describes the methods adopted to collect and analyse data: qualitative methods and thematic analysis.

3.1 Qualitative research

The research conducted in this thesis is placed in the epistemology of qualitative research. The aim of qualitative research is to understand issues or particular situations by investigating the perspectives and behaviour of the people in these situations and the context within which they act. That is why qualitative research is conducted in natural settings and uses data in the form of words rather than numbers. Therefore, qualitative research supports researchers in understanding people, contexts, and events. Moreover, it supports the understanding of an event from the participants' point of view in context. However, in quantitative research, this essential part of research is lost (Myers and Avison, 2002). According to Myers and Avison (2002), qualitative research can be positivist, interpretative, and critical.

- Positivist studies tend to believe that there are properties to measure reality independent to the researcher. These studies try to measure theory to understand phenomena through variables and hypothesis testing.

- Interpretative studies tend to understand events from the meaning given by people from their shared knowledge, documents or artifacts. Interpretative methods try to make sense of the situation where research is developing.

- Critical research studies contradictions, conflicts and opposition in society that constrain their ability to move forward.

This thesis also follows an interpretative approach, composed of seven principles based on i) iteration on the data, ii) extracting the meaning of its parts and as a whole; iii) reflection on historical circumstances around the situation under

research; iv) the interactions between researchers and participants; v) application of methods and theories that support generalisation; vi) sensitivity to identify possible contradictions between data collected and theory as well as vii) to respect different interpretations, and possible biases (Klein and Myers, 1999).

However, qualitative methodology is not exempt from criticisms. One criticism has claimed that it lacks rigour or validity in its findings. Some authors advocate for triangulation to overcome the problem and offer more rigour to the scientific findings. Triangulation proposes the mixing of qualitative and quantitative methods, for example, survey data and interviews (Olsen, 2004). Others advocate for using thorough documentation practices, using a combination of methods and sources, and evaluation strategies, to provide validity to the collected data as well as evidence for and against researchers' arguments (Silverman (2013)).

This thesis aims at investigating engagement considering the participants' behaviour, relationships and feelings, proposing strategies to better understand and enhance it. To this end, this research follows an interpretative qualitative methodology. This is because the work presented here reflects on participant behaviour, which is better observed through qualitative methods (Kaplan and Maxwell, 2005).

3.2 Research process

As a general framework, this thesis is close to action research. Action research is an iterative process where researcher and practitioner are involved in a series of iterative activities that result in knowledge expansion (Simonsen, 2009). McKay and Marshall (2001) propose a research process for action researchers based on two separate but interconnected cycles: one of them represents and focuses on the problem-solving interest and the other cycle represents and focuses upon the research interests. These two cycles help researchers to be much more explicit about the reflection and learning process. The cycles are composed of nine steps that run in parallel and are interlinked, as presented in Figure 3.1.

On the one hand, the green colour text and arrows represent the cycle where the interests of the researcher prevail. This cycle starts with a researcher becoming aware of the problem. Once the problem is identified, the researcher starts understanding the context, who the stakeholders are and other relevant facts about the issue under study. Thus, the researcher, and maybe with the collaboration of practitioners, start tracing a plan of how to proceed to solve the problem and start implementing specific actions towards the solution of the problem. Actions are monitored and evaluated in terms of the impact on the problem solution. After this step, the researcher evaluates

if a successful solution has been reached, or if the research has to be redirected instead. On the other hand, the black colour text and arrows represent the cycle where the problem-solving interest prevails. The researcher has a research question that they wish to pursue. Once that is defined, the researcher engages with relevant literature to identify possible theoretical frameworks to be adopted to answer the research question. Afterwards, the researcher plans and designs the set of actions to be conducted in order to answer the research question. Actions are conducted with the researcher reflexively engaged with their theoretical perspective. Actions are monitored and evaluated in terms of the effect of the actions on the research question. If these have been answered or resolved, the researcher can finish the research. Otherwise, they should reformulate her research and re-enter the cycle.
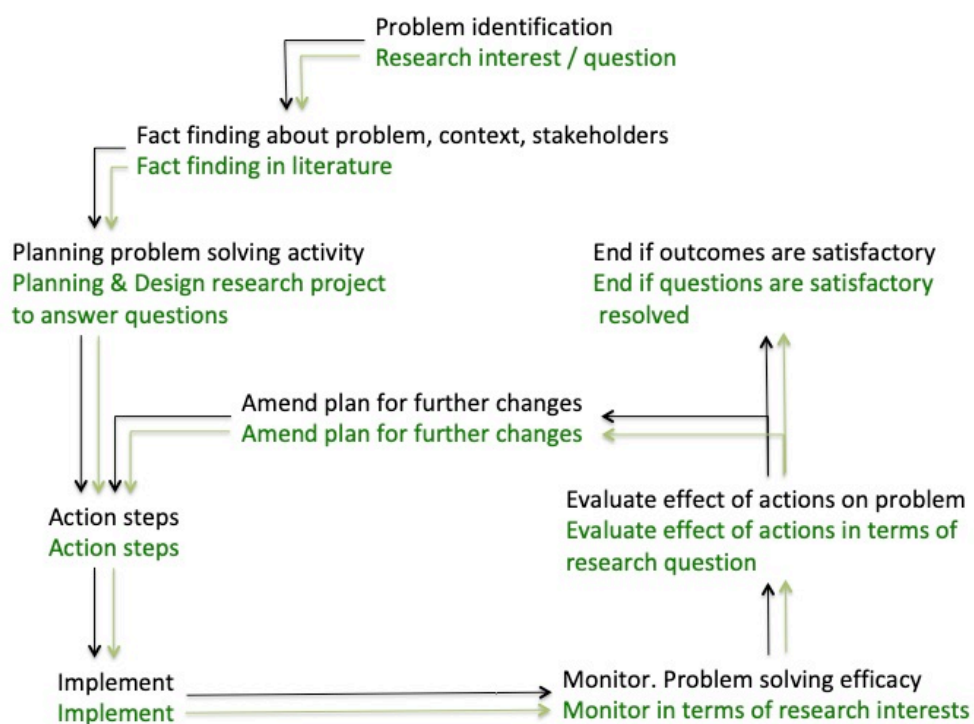
Figure 3.1: Green: research interest cycle in Action Research. Black: The problem solving interest in Action Research. Adapted from McKay and Marshall (2001)

Action research, however, is not exempt from criticisms, and some researchers claim that it may be regarded as being a little bit more than consultancy. In the work presented by McKay and Marshall (2001) they suggested that action research differs from consulting in that the latter ignores the research interest cycle whereas the former acknowledges it and adds the corresponding activities to ensure that the research aim is reached. Another factor for criticism refers to the lack of scientific rigour with respect to data validity and generalisation. Baskerville and Wood-Harper (1996) proposes that researchers should fit the research methods to the problem in order to produce valid research results while relying on the cyclical structure

of action research, data collection and evaluation. Furthermore, as Baskerville and Wood-Harper (1996) point out, action research is contextualised and hard to generalise, a factor that can be sorted by adding more phases of testing or by applying triangulation.

Nonetheless, this thesis followed a simplified description of action research, as presented by Steen (2013).
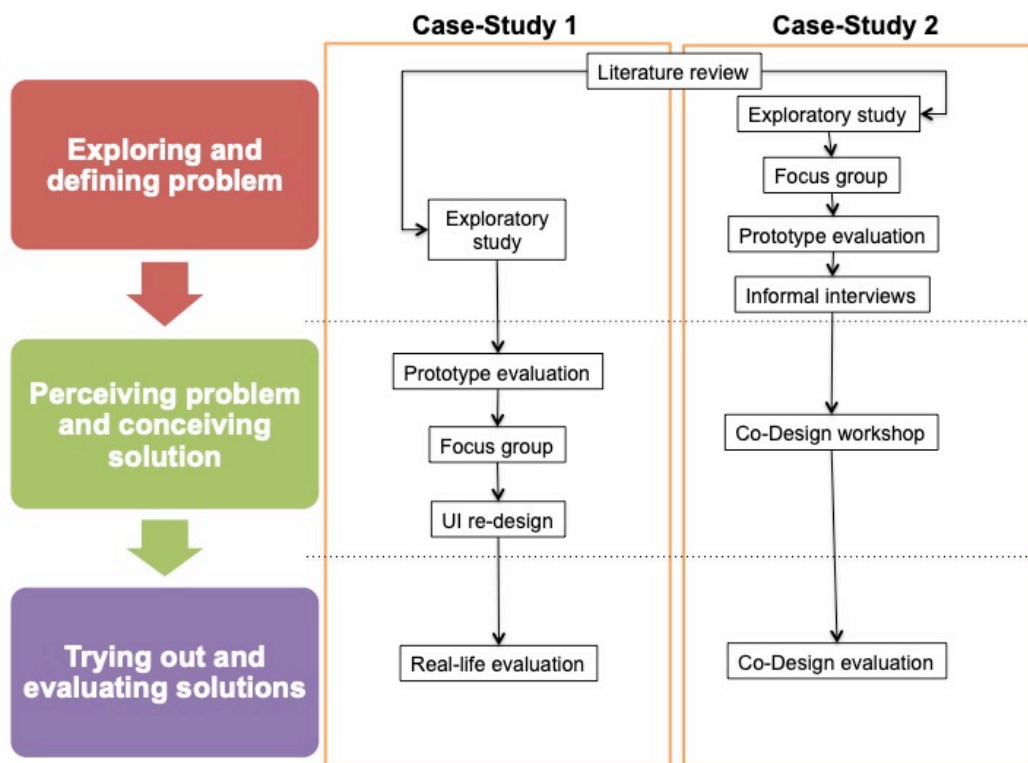
Figure 3.2: Research process followed in the thesis

The framework proposed by Steen (2013) adheres to the definition of co-design provided by Sanders and Stappers (2008): *"collective creativity as it is applied across the whole span of a design process."*. Moreover, Steen (2013) claims that co-design includes different approaches that focus on user involvement (Iivari and Iivari, 2011). Such approaches range from usability testing, as an attempt to move designers towards users where users are involved as informants (Iivari and Iivari, 2011), to PD, as an attempt to move users towards designers and researchers where participants are more involved in a hands-on role (Iivari and Iivari, 2011). Therefore the reasons to select this framework to guide the retrospective analyses of the work presented in the thesis are twofold. On the one hand, co-design is understood as a strategy to involve users in all the phases of the creation of the system, including its evaluation. On the other hand the framework considers reflexivity to make visible the relationships in the design process (Pihkala and Karasti, 2013). Moreover, according to Steen (2013), when participants are aware of the importance of their

participation, they can organise their contribution more effectively, learning, creating and addressing problems that would lead to common solutions. The framework described by Steen (2013) proposes three steps that have guided the retrospective analysis of the data in this thesis, see Figure 3.2.

The first phase, exploring and defining the problem, is about identifying and defining the problem and the community. The analysis of the literature facilitated the identification of the issue to investigate, that is, engaging participants to actively contribute in collaborative systems aimed at constructing digital resources. The first studies conducted in each of the two studies supported the identification of the problem in real-life settings and the target communities. In Study 1, data was collected following a think aloud protocol, semi-structured interviews, desktop registration, log file and emails. In Study 2, the methods employed were semi-structured interviews, semi-structured phone interviews, observations, a focus group, a prototype testing, and informal interviews.

The second phase, perceiving the problem and conceiving possible solutions, is about proposing different solutions to participants. In Study 1, participants were involved in prototype evaluation and a focus group. In Study 2, participants were involved in a co-design session to prototype an online repository.

In the third phase, trying out and evaluating solutions, both studies concluded with an evaluation of the possible solutions. In Study 1, the evaluation was done through methods such as emails, diaries, a questionnaire, and by contributing to the digital resource. In Study 2, the evaluation was done through the evaluation of the prototypes co-designed.

3.3 Reflexivity as an orientation

In this thesis, reflexivity is an orientation that has informed data interpretation and analysis. The interpretation of data is a reflexive exercise through which meanings are made rather than found, making reflexivity consistent with the interpretive approach of the thesis. An important element in reflexivity refers to situating the researcher socially and emotionally in relation to participants (Mauthner and Doucet, 2003).

Reflexivity is based on interpretative skills. According to Day (2012), reflexivity conveys a deeper consideration of the subjectivity and role of the researcher in the process of knowledge production. Furthermore, she adds that researchers might pay more attention to the reflexivity of participants to avoid the divide

between researchers and participants. Interpretations are based on our intuition, judgement and communication skills to perceive and translate interaction in context. An important factor of interpretation is intention, as it helps in the articulation of observations and other activities in the design process considering the goal to be reached. Whereas reflexive methods support the understanding of existing phenomena, sensitivity is required to establish communication and interaction with participants and to raise researchers' awareness during intervention. The methods used to enhance sensibility and the methods used to enhance reflexivity build up the theoretical framework for good interpretation (Mörtberg et al., 2010). Along these lines, Pihkala and Karasti (2013) see reflexivity as an ongoing strategy to reason about the involvement of participants and researchers. For them, enacting reflexivity means being critical with the research context while, at the same time, considering it as an opportunity to change practice (Pihkala and Karasti, 2016).

However, reflexivity is not exempt from criticisms and some researchers question i) whether the researcher is accountable for expressing and emphasising others' reflection, examining the capacity of the researcher to represent others' opinions and interpretations and ii) the process of reflection, as it lacks method or theory (Lynch, 2000). As remarked by Day (2012), researchers might need to consider reflexivity as a collaborative, interactive and social act where colleagues and the academic community can be considered part of the reflexive process. Providing a dialogue around what was discovered in the research process and the methodological approaches might be considered another way to validate the research conducted. Another critique exposed by Pillow (2003), refers to the positivist view of reflexive approach which, according to her, tends to see success in failure cases. Moreover, Pillow (2003) introduces the concept *reflexivity of discomfort* to refer to how "*reflexivity reveals its own imperfections and it is disruptive, rather than a virtue or a strategy of validation*". Pihkala and Karasti (2016) propose that reflexivity should involve, on the one hand, deconstruction, critique and paying attention to what is problematic, and, on the other hand, reconstruction, generative contributions and commitment to change practice.

Reflexivity is an orientation to design that considers relationships, personal expectations, and commitments (Karasti and Blomberg, 2012). Embracing it as an orientation in PD, and in other user-centric and collaborative design approaches, enriches both the research and design disciplines (Pihkala and Karasti, 2013). On the other hand, co-design is a design approach that improves processes of idea generation, service or product development, decision-making while promoting cooperation and creativity, to improve users' satisfaction and engagement over the long-term (Steen, 2013).

The co-design process is composed of four phases: pre-design, generative, evaluative, and post-design where researchers and designers facilitate the design process and take the necessary decisions in the absence of complete information (Sanders and Stappers, 2014). These phases support the exploration of the problem and the envisioning of alternative situations and solutions (Steen, 2013). In this process, reflexivity could facilitate the identification of what is problematic as it involves deconstruction and analysis of the design process as well as reconstruction and commitment to change (Pihkala and Karasti, 2016).

Reflexivity and co-design investigate engagement from two different perspectives. On the one hand, in a reflexive orientation engagement is studied by reflecting on the dynamics of the relationships, commitments, and expectations in and beyond design (Karasti and Blomberg, 2012)(Pihkala and Karasti, 2013). On the other hand, co-design reflects on the 'making' of artefacts to investigate participants' engagement through the involvement of people, technology, and the settings during all phases of the design process (Sanders and Stappers, 2014)(Karasti and Blomberg, 2012). Reflexivity makes researchers more aware on how the situation is evolving (Light and Akama, 2012). By reflexively analysing the design space, the co-design pocess can be largely benefited. Investigating other aspects, such as relationships, commitments and expectations, provides an opportunity to understand the process of engagement from other perspectives that can influence it.

3.4 Data collection: qualitative methods

In this thesis, data was collected through diverse inductive qualitative methods, including observations, interviews, and documents (Kaplan and Maxwell, 2005).

- Observations - this method refers to the active involvement of the observer. Contrary to passive interaction, this approach allows the observer to interact, ask questions and engage in conversation with the participants, supporting detailed descriptions of events or situations in context.

- Semi-structured interviews - The aim of the interview is to elicit a participant's reflection on their own experiences and views. Moreover, this method provides the researcher with a flexible approach that allows them to ask deeper questions following participant's answers or to elaborate on them if something is not understood. A variant of this approach is a focus group, where more than one person is interviewed together allowing the participants to react and respond as the conversation develops.

- Documents - This approach includes the analysis of documents, text, pictures or artifacts related to the issue under investigation.

The strengths of qualitative research methods lie in their usefulness for understanding the meaning and context of the phenomena studied, such as social, cultural, organisational, and political concerns around the case under study, and the particular events and processes that make up these phenomena in natural settings. It further investigates how participants perceive those events in the setting where the study is being conducted (Kaplan and Maxwell, 2005).

Qualitative methods are helpful to i) determine what to measure and the nature of the results; ii) to understand the causes of specific behaviours; iii) to investigate the influence of the context; iv) to understand what processes lead to a specific result; and v) to study emergent processes and their development (Kaplan and Maxwell, 2005).

3.5 Data analysis: thematic analysis

In this thesis, qualitative data was analysed following a thematic approach. Braun and Clarke (2006) defined thematic analysis as a method to identify, analyse, and report common patterns in the data under analysis and supports its detailed description. Themes capture something important about the data related to the research question and can be representative of the data set. Thematic analyses can be accomplished following two strategies. The first is an inductive, or data-driven method, where themes do not follow a pre-existing coding. A deductive, or theoretical method, is the second type, where themes are identified to answer a specific research question and the analysis is driven by the theoretical interest in the data. Moreover, when following a deductive approach to conduct the thematic analysis, an exhaustive literature review is recommended, as it can make the researcher aware of subtle aspects found in the data. In this thesis I followed an inductive approach, for its flexibility to identify common topics. I relied on the literature on motivation and UX to support the interpretation of data and the identification of themes. The process of thematically analysing a data set is composed of the following steps (Braun and Clarke, 2006):

1. Familiarising with the data. This phase involves reading through the data before starting to code. At this time, initial coding can be conducted. In this phase, verbal data can be transcribed which supports the familiarisation process. The phase finished when a general idea of what the data is about and what it says is generated. '

2. Generating initial codes. Codes identify an interesting feature of the data. Codes can be data-driven if they depend on data, or theory-driven if they respond to specific questions.

3. Searching for themes. Codes and themes differ in that the latter are broader than the former. In this phase, codes are clustered and combined in overarching themes.

4. Reviewing themes. Themes are refined and reorganised according to the revision of codes per theme, which consists of reconsidering the appropriateness of the theme, and considering the theme's appropriateness with respect to the whole data set while reflecting on the meaning of the data set.

5. Defining and planning themes. Each theme should be accompanied by a detailed description, considering the theme itself as well as its relationship with others. Furthermore, names should be representative of what the theme represents.

6. Reporting. The analysis of the themes should be an account of the themes obtained from the data and across themes. The analyses of the data should argue the research question that guided the analyses of the data.

Thematic analysis is a flexible method in terms of what can be said about the data. For this reason, it is important to be rigorous in terms of research question formulation and organisation of the analysis. Furthermore, it is crucial to identify a theoretical framework to support the analytic claims. Otherwise, thematic analysis is restricted to description.

Study 1

4

The first study reported in this thesis investigates *engagement in use* in the co-design of a collaborative system to co-create a linguistic resource for Italian. Starting with the description of the sociotechnical background around the study, the first phase of the process describes an exploratory study where participants evaluated a preliminary version of the collaborative system. From here, an initial set of factors that hinder and facilitate engagement emerged. The next two phases aimed to refine this set through prototype testing, a focus group, and a real-life evaluation of the collaborative system.

4.1 Background

This section frames the sociotechnical context around the collaborative system to engage in the co-creation of the linguistic resource for the Italian language. This section describes the technical context around the collaborative system, including a description of the two user interfaces (UIs) used to contribute, as well as the social context around it.

4.1.1 Technical context

The digital resource involved in this study corresponds to a linguistic resource developed at the University of Trento (Giunchiglia et al., 2017). On the one hand, the resource is aimed at overcoming the limitations identified in the related work section, namely incompleteness, lack of maintenance, licensing, and unavailability. One the other hand, the collaborative system aims to collect contributions while keeping participants engaged. This resource presented a structure somewhat similar to that of WordNet, where words were organised in sets of synonymous words known as synsets. It was composed of language-specific databases or vocabularies and involved, using the WordNet terminology, the generation of various language elements (Miller, 1995) namely:

- the gloss represented the definition of the word

- the POS, which stands for Part of Speech, represented the category in which a word can be translated. It had four different values: noun, adjective, adverb and verb

- the senses corresponded to the words or lemmas that shared the same definition as the one included in the gloss

- the examples were the uses of the words put in context

Initially, the vocabularies were created automatically by importing existing resources where the English WordNet had been translated into other languages. However, as vocabularies existed at varied levels of completion that could not be fully automated, this also required manual input.

As a consequence, a human computation (Law and Ahn, 2011) approach was adopted where contributions were facilitated by translating tasks. A translation task was composed of the four language elements, that is, gloss, POS, sense and examples. It was divided in two parts: the source language part, in this case English, which suggested the concept under consideration; and the target language part, which was the corresponding language, in this study, Italian. Tasks could be completed in two ways:

- by translating the above-mentioned language elements. This activity could actually happen in two ways: by translating the concept as a lexical gap, for a word in a language for which there was no corresponding word in another language (for example, there is no word in Italian to express the English verb to bike); and by translating a concept into a language for which there was a word in another language (e.g., pianta in Italian and plant in English)

- by evaluating the correctness of the completed tasks (e.g. the word spelling, the chosen example)

The system developers designed a model to organise contributions. In the model, people had a role assigned, where each role had a set of defined responsibilities, (Giunchiglia et al., 2015). The roles were as follows:

- The translator was the person who translated tasks. After completion, she sent tasks to the evaluator. The translator also had to accommodate the corrections suggested by the evaluator

- The evaluator checked the translator´s tasks. If a task was considered wrong, the evaluator would send it back to the translator to have it corrected, whereas if the task was marked as correct, it would be stored in the linguistic resource

The model included a task workflow process. The process, in Figure 4.1, represented how participants would communicate in the system through translation tasks. Initially, the translator retrieved a task and, once it was translated, she had to save it. The next time she triggered the task, she could send it to the evaluator. If something was not correct, the evaluator could send it back to the translator with a message indicating where the mistakes were. If everything was correct, the evaluator would send the task to the resource.
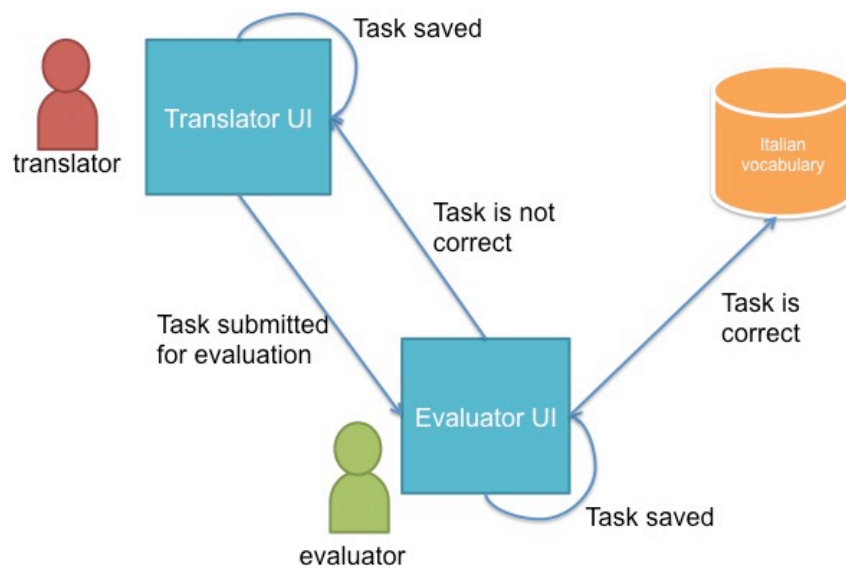
Figure 4.1: Task workflow

The contributions to the Italian linguistic resource happened through a dedicated online UI that was designed to facilitate the completion of tasks, and the interactions among the different participants involved. The system had two different UIs: one was designed to facilitate translation, presented in Figure 4.2, and the other to facilitate the evaluation, presented in Figure 4.3 (Huertas-Migueláñez et al., 2018).

Translators´ user interface

The preliminary version of the UI, (Figure 4.2), was designed to facilitate translations from English WordNet concepts into italian. In this preliminary approach, each participant had a set of tasks to translate:

- the top part contained the concept in English

- the bottom part contained the form to compile a translation

If the concept to be translated did not have a translation in Italian, it had to be translated as a GAP. Otherwise, the participants compiled the translation form by 1) adding the gloss; 2) selecting the corresponding POS from the pull-down menu; 3) adding a translation for the word provided and an exceptional word form, that is, an irregular plural form, irregular superlatives or irregular verb conjugations, when available; and 4) adding an example. Once all the fields were completed, she had to save the translation first, clicking the 'Save' button, and then submit it for evaluation. By clicking on the button "Translate Next" a new English concept to be translated would be displayed.

Figure 4.2: UI design to facilitate the translation of English concepts into Italian

Evaluators' user interface

In the UI to evaluate tasks, (Figure 4.3), the screen was divided into two different areas: the left-hand side contained the concept in English; the right-hand side contained the translated concept to be evaluated. Here, the evaluator assessed the translator's work. Every element of the translation had to be marked as either right

or wrong. If the task was deemed to be correct it could be sent to the linguistic resource by clicking on the 'Submit for UKC validation' or it could be kept for further revision by clicking the 'Save' button. By clicking the button 'Validate Next' a new concept would be triggered. If a task was not correct, it could be sent back to the translator with instructions as to where the mistake is so that it could be revised.
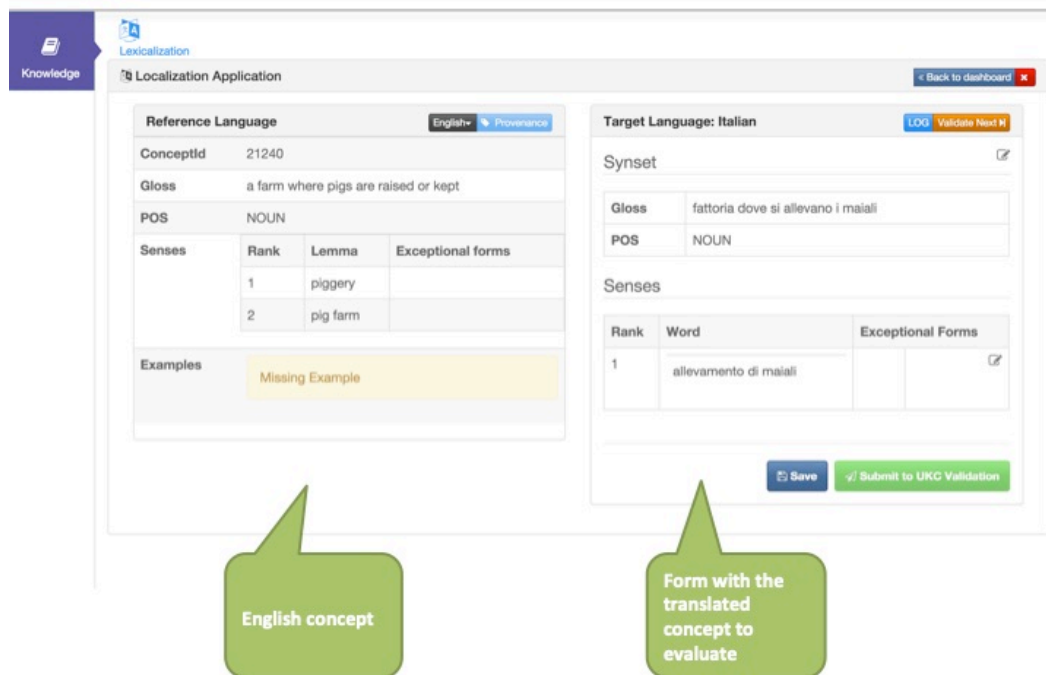
Figure 4.3: UI design to complete an evaluation

4.1.2 Social context

The research presented in this study was carried out at the University of Trento, a medium sized University located in Trento, the capital city of Trentino, a region located in Northern Italy. The University is composed of 14 departments and centres that promote and coordinated research projects in cooperation with national and international institutions. One of these departments is the Department of Information Engineering and Computer Science, where this study was conducted. The department is one of the largest in terms of people and funded projects. The main research lines in the department correspond to generation and dissemination of computing methodologies, creation of technologies, and collaboration with other research centres to demonstrate the applicability of the solutions found. In this context, design was considered a complement in the implementation of systems and not the object of investigation.

The activities presented in this study have been developed in one of the research groups of the Department of Information Engineering and Computer Science. The research group was composed of eight Ph.D. students, four PostDoc students, four developers, and one faculty member. The group's main research lines were the development of systems to support NLP tasks, mainly word sense disambiguation (Bella et al., 2016) and linked data. The group also collaborated in several EU funded projects such as Smart Societies (Scekic et al., 2015). The group led the ambitious co-creation of a linguistic resource whose collaborative system allowed contributions through a UI. To this end, four developers, a Ph.D. student, one PostDoc student and a faculty member were involved in the definition of the architecture, the logics, and the UI. In November 2014 the linguistic resource and the first version of the UI, Figure 4.2 and Figure 4.3, as well as the interaction model, Figure 4.1, were presented in a workshop, where attendees belonged to different research groups across Italy, Asia, and Europe. One of the attendees was an associate professor in Linguistics from the University of Macerata who showed her interest in the project and established a collaboration with the research group at the University of Trento. In the summer of 2015, I started my research in the linguistic resource, mainly as a UI designer. While I was involved in the UI design, the research group went through a difficult economic situation forcing many of their members to find other positions in other research groups or companies. More precisely, by the second half of 2016, the developers' team was reduced to a fourth of its original size and the PostDoc student moved to another research group. Basically, the team was reduced to one developer, one faculty member and myself. At the same time, the developer was in charge of the development and maintenance of the other projects in the group, and had a list of project preferences agreed with the faculty member. A few months after my collaboration concluded with the research group, the last developer involved in the co-construction and maintenance of the linguistic resource left the group. Since then, no one dedicates time to it. Currently the UI is not accessible.

4.2 Exploring and defining the problem

This phase aims at identifying the target community and the factors that facilitated or hindered engagement by analysing the data collected through the evaluation of the preliminary version of the UI. The study was conducted between November 2015 and January 2016 and was aimed at observing different aspects of the usability of the UI.

4.2.1 Participants

To recruit participants, the snowball sampling methodology (Biernacki and Waldorf, 1981) was followed. The associate professor of Linguistics from the University of Macerata who showed her interest in the project was the starting point for the identification of a group of participants. At her university, she proposed a collaboration with postgraduate students through a university seminar.

For the study, five postgraduate students in Modern Languages for International Communication and Cooperation (four female and one male, age range: 21 - 25) and one associate professor in Computational Linguistics (female, age range: 35 - 40) from the University of Macerata were involved. The students, whose mother tongue was Italian, had a good knowledge of English; therefore, they correctly responded to the requirements of the activity. The professor had a higher degree of expertise than the students regarding the background theory and the procedures of the project and was an expert in the fields of Linguistics, Terminology, and Languages for Special Purposes (LSP), while the students could be considered semi-experts in these areas and in LSP Translation. During the study, students were given the translator role; whereas the professor had the evaluator role. Every student had a set of tasks to complete, whereas the professor had to evaluate them all. Students had experience in translation using corpora, but they had never used a system like this one.

4.2.2 Data collection and analyses

The system developer assigned the translators sets of concepts that referred to the location domain, represented as a large tree. Each set contained between 100 and 500 English concepts, where every concept corresponded to a task. Three months after assigning the concepts, I joined the project and went to the University of Macerata to conduct a user study.

All of the participants agreed to be voice-recorded, desktop-recorded and allowed the use of the resulting data for further analysis. Data was collected using an array of methods as reported in Table 4.1: i) background questionnaire to collect demographics of the participants; ii) think aloud protocol (McDonald et al., 2012) to understand and observe how they completed tasks. They were asked to interact with the online UI for the time required to complete three tasks; iii) desktop video-recording while interacting with the UI; iv) the log file of the system; v) word file containing extracts of the emails exchanged between the professor in the University of Macerata and the PostDoc student; and vi) semi-structured interviews (Galletta, 2013) divided into two parts: the first one to understand how they perceived the

UI and the second one to understand the complexity of the tasks. In the first part, questions were grouped in the following categories:

- feelings during the study;

- influence of the circumstances occurring during the interaction;

- personal motivations to contribute.

Method	Data source
Background questionnaire	6 participants' demographics
Think aloud protocol	6 audio interactions and transcription
Desktop video-recording	6 video interactions and transcription
Semi-structured interview	6 audio recordings and transcription
Log file analysis	1 system log file
Word file analysis	1 file containing email text

Table 4.1: Methods and data source for the exploratory study

In the second part of the interview, questions were related to the complexity of the tasks. Interviews were transcribed and analysed following a reflexive orientation while performing a thematic analysis, according to a deductive approach. Findings are the result of the triangulation of the semi-structured interviews, the observations during the think aloud protocol, the video recordings, the emails, and the log files (Olsen, 2004).

4.2.3 Findings

Participants interacted with the UI for three months, coinciding with a period of intense academic activity. In this period they decided how to organise the tasks they were asked to complete, allocating them, mainly, during their free time or between lectures. Figure 4.4 presents the total number of concepts translated and evaluated.

By the end of the study, participants had translated 152 concepts using the website and a total of 48 concepts were evaluated. The study was conducted in one of the IT classes of their faculty. During the think aloud protocol I could observe that participants were very precise when translating. First, they read thoroughly the word in the concept to be translated. After, they consulted several online dictionaries, both bilingual and monolingual, such as Cambridge Dictionary[1] or Oxford Dictionary[2]

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[1] https://dictionary.cambridge.org/
[2] https://www.oxforddictionaries.com/

for English, or Treccani[3] for Italian. One of them also said she consulted an Italian paper-based dictionary; online resources, such as governmental sites or trusted news agencies; and images. Once they finished with their research, they decided whether the concept could be translated as a lexical GAP or not. If not, they translated the word, the gloss and added the part of speech. At the end, they introduced an example by looking for inspiration in online images or news.
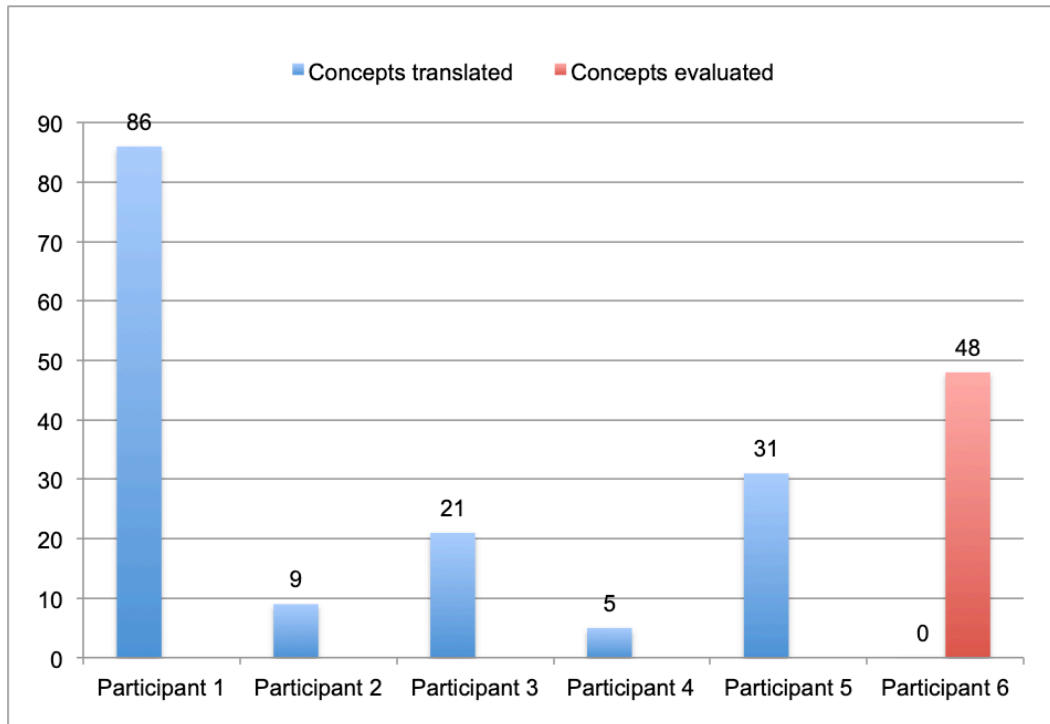
Figure 4.4: In blue, total number of concepts translated. In red, total number of concepts evaluated. The numbers on top of each column represent the exact number of concepts.

System stability

The preliminary version of the website was stored in a server that crashed several times during the three months of the study. When I met one of the participants, he expressed his frustration by saying "*I hate this system*" and later he explained the many problems the UI had.

When explaining these problems, I could feel their frustration and even anger due to the technical problems. Interestingly, although the system broke several times, students found a creative way to complete tasks. Participants showed their **resilience to contribute** when they adopted alternative measures to continue contributing, in spite of system's failure. In this case, participants decided that the next time the

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[3]http://www.treccani.it/

website was running, each of them would annotate all the tasks they had to translate in a Word file which they used to complete their tasks.

> Participant 5: "*I created a table in a Word file, and I generally work on the Word file and later I transfer everything to the website. I have around fifty or sixty left.*"

What participants learnt was that every task had an id and that, in the url of the UI, the last digits corresponded to the id of the task. Whenever they wanted to retrieve a specific concept, they changed those numbers.

> Participant 4: "*What I do most of the times is I save the "concept id" in my word file so that when I want to retrieve that concept, I just have to insert this number [the concept Id] and I get to the page with the English concept.*"

> Participant 5: "*I know that I have this task to compile. So I open the platform and write three, five, two, I press enter and I get to the task directly.*"

Interestingly, some of the participants did not mentioned that they were using a word file. I only knew about it when one of the participants explained the strategy that they all agreed upon in order to continue with their translations. Moreover, some participants with a translator role shared some concepts and that created conflicts among them, as they could see that a task that they did not retrieve was completed. After discussing it between themselves, those that had concepts in common decided to complete them alternatively.

> Participant 4: "*Sometimes, my concepts belong to "region" and Participant 5 has concepts from "line". Very often words are very similar. In that case, we compare or if the words are the same, only one of us completes the task.*"

Resilience to communicate corresponds to the alternative means for communication adopted by participants to communicate between themselves. Translators and evaluators could communicate according to the task workflow designed by the system developers. However, because the system crashed often, students preferred to contact the professor by email regarding doubts about the completion and correctness of their tasks. In this case, they preferred email as it was faster and trustworthy; they were sceptical about the UI's stability. Nonetheless, the professor had to keep both updated: students by replying to their email, and the UI to store the evaluations of the student's tasks.

Participant 5: *"What I do is I work on Word and then I send it to the professor. If she says it's ok, I complete the online form and then I send it to evaluation, once she gives me her feedback. I do it this way because it's better if four eyes control rather than two."*

Therefore they substituted the UI and its task workflow process for the email. Translators only used the website to submit tasks that were correct. The rest of the time they worked and iterated on the Word file. That might justify the low number of translated concepts presented in Figure 4.4.

Usability

The UI of the collaborative system had several issues that hampered participants' performance and motivation. These issues were related to the interface design, whose functionalities did not work correctly, affecting the experience of users when interacting with the UI.

Form design and organisation. While translating words, participants were compiling the form in a different order from that shown on the UI. For example, in the UI the first thing to compile was the gloss of the concept. However, what participants compiled first was the word. Moreover, they had to scroll up and down the screen to get to see the whole compilation form. For some of them it was not a problem whereas for some others it was uncomfortable for the compilation of tasks.

Participant 2: *"It would be nice to have everything on the same screen so that in one glance you can read everything"*

Participant 3: *"Considering that we are comparing two languages, and the same fields are in both concepts, for example, the gloss, the POS and the words. I think, an interface divided in two vertically, making the correspondence of every field, it would be more intuitive, more obvious. You take more advantage of the horizontality rather than the verticality."*

Translators noticed that very often examples were not included in English concepts. However, in this system, it was mandatory to introduce at least one example to complete the compilation task before continuing to the next concept to be translated. While some participants understood that they were required to understand the use of a word in context, others complained that, even though there was no example in English, they had to introduce one and sometimes this part of the task was very complex.

Participant 5: "*Most of the time the English example is not included. When I found it, I translated it or I searched for it in some university site, because when we talk about scientific concepts, finding an example is not easy.*"

Participant 4: "*Sometimes I don't complete the example because I don't have any idea in that moment. Maybe I want to translate a specific number of concepts in a day and I can't find the example, so I continue. What I do is adding a mark to make me notice that something is missing, so that I can come back and finish it.*"

Visualisation. The UI provided an overview of the number of concepts that had been translated in the specific vocabulary for each role in the form of statistics. This way of visualising their progress was not easy to understand and participants disregarded it. However, most of the users clearly expressed the need for a visual way to monitor their progress.

Participant 2: "*The first thing that appears after log-in are the statistics. They are not useful for me, or at least I don't usually use them.*"

Participant 5: "*I would like to have an interface here with all the words, one under the other. I mean the same interface with the list of words so that if I want I can leave one concept and select another one.*"

Missing functionalities

Participants with a translator role could not communicate through the system: there were no facilities to allow communication between them. Therefore, they chose to do it face to face.

Participant 4: "I talked with Participant 1 on whether to save first and then submit to evaluation or how to proceed."

Task workflow

Participants agreed that one of the most prominent issues was related to the retrieval of tasks. Once a task was completed, students had to save it in their account before sending it for evaluation. Whenever they logged-in to the system, the first task visible corresponded to the task that was completed but had not been sent to the evaluator.

If the participant had many tasks stored in this way, they had to go through all those tasks until they could find an uncompleted one.

> Participant 5: "*Every time I log-in I see the first concept. So I see all these tasks that I have completed and if I want to move forward, I have to click on 'translate next' until an uncompleted task appears. So I prefer to work on my Word file.*"

Another problem was that at some point the algorithm to go through tasks and retrieve them failed and they could only get up to a task and could not continue.

> Participant 5: "*At certain point, I get to a specific task and the website blocks. I mean, I click on 'translate next' and nothing happens. So from all what I had assigned, I can't see around 60 of them [tasks].*"

All participants agreed that they were getting random words and this made them perceive the system as disorganised. The issue was related to the process used to retrieve the words in a subtree, based on a depth first order algorithm to run through every node, that is, it explored the tree vertically, node by node till the end of the branch. When participants requested a new task through the UI, the algorithm moved to a new node with a very different meaning. Moreover, when the algorithm reached a branch's end and jumped to the first node of a new one, the content of that node was so different that it made participants feel it was disorganised.

> Participant 6: "*By logging in as a evaluator I get random entries.*"

> Participant 4: "*I think that's how the system works because everytime I access, the word retrieved is different. There is not a pre-established order on this words. It's not even organised progressively. I would have ordered the words in alphabetical order or numerical order. Instead they are random numbers. There is not a progressive order of the words. The way I can visualize the words is wired.*"

The evaluator felt overwhelmed by the number of tasks she had to evaluate, around one thousand. She felt frustrated, too, by (i) the number of times the server crashed, hindering her contributions to the linguistic resource, and (ii) the impossibility of evaluating all the tasks from a specific translator consecutively, as the website presented the tasks entangled among participants.

Participant 6: "*If you have to coordinate a group of students it is ok, but if you have to coordinate them and in addition check their tasks, it's very time consuming. If you have many checks to do, either it's your first work and you don't have any other duties, or you overlook at the tasks quickly. There are many things to control in every task.*"

One of the features of the system was that, in order to send a task to evaluation, they had to save it first, then trigger it again, and send it to evaluation. Translators of the study were mainly saving their translation tasks and they hardly sent them to the evaluator. This was the reason why they were shown translated tasks when they accessed the set of tasks: the system showed first those concepts that were saved and, then, those that were not translated. Therefore, the more tasks they saved, the more words they had to go through until an uncompleted task would be retrieved.

Participant 5: " *I know that in the interface I can save without sending to evaluation, but with the problem that everytime I access to the system I get the tasks that I have completed and I have to click on "translate next" until I get to one I haven't completed, I prefer to make a draft in word and then transfer the good copy to the UI.*"

Expected gains.

This driver refers to the intrinsic benefit that a participant might expect to obtain after *engaging in the use* of a collaborative system. In particular, in this study it was articulated as personal gains such as the satisfaction of curiosity, affirmation of ego as well as from a cognitive point of view.

Learning. Learning was articulated in acquisition and knowledge applied.

Participant 4: "*I have extended my knowledge. In the beginning I thought, ok, I have the chance to increase my list of associated words between English and Italian. Instead, at the end I really liked this aspect of working in my mother tongue and understand the nuances and understand the differences.*"

In spite of the troubles with the UI, participants reported being enthusiastic. Although they noticed that it was very demanding, the tasks allowed them to learn nuances in the meanings of the words, engaging them even more.

Participant 4: "*It helped to enrich my vocabulary and it is very useful to understand the language*".

Participant 1: "*It is very demanding because it needs a lot of research. It required a lot of time. It was a very enriching work*".

In general they felt that the experience of translating this type of task was enriching and challenging. All the participants agreed in saying that they learnt something from this experience:

Participant 5: "*Not only I have improved my IT skills but also I have learnt words that I would not expect to learn*".

Participant 2: "*I had to study in depth the words that I had to translate. Also those I thought I knew, I had to further investigate them to be sure and accurate. Moreover, I learnt a new research approach*".

Participant 3: "*There are words that I didn't know before and I have now learnt thanks to this study*".

Idealism. For participants, contributing to the system had a sense of social good. Contributing to the creation of a linguistic resource in their mother tongue language proved to be another motivation for the participants. Moreover, creating knowledge in their mother tongue, knowing that someone looking for a translation could benefit from this resource, was another reason to contribute.

Participant 5: "*When I translate I try to be as precise as possible so that if someone looks for a translation can understand and use it*"

Curiosity. The theme of curiosity clearly emerged as an initial motivational factor from the words of Participant 6, who originally volunteered to run the study involving her students. She elaborated on her research interest in main drivers of participation, explaining that she previously worked in the development of a similar database. Specifically, she was in charge of coordinating, modelling and creating a glossary for advertising.

Participant 6: "*I was curious to see how a resource like this is built from the very beginning. I was also interested on how useful this system could be to my advanced students. My interest is also to see how it improves over existing ones and how I can contribute to improve it from inside*".

According to her, this type of resource is very useful if you need to consult, get some deeper information on a term and also to understand language structures. However, she strongly believed that the special structure could be only understood by people with good level of knowledge in Linguistics.

Despite her initial enthusiasm, the contribution of Participant 6 was below expectations mainly due to the functionality and usability issues of the system. She was supposed to act as the evaluator of her students' work using the UI but soon she abandoned it and focused on the word files they were sending her.

4.2.4 Discussion

The following table, Table 5.8, summarises the factors to facilitate or hinder engagement that emerged after the analysis of the data in this first study.

Barriers	Drivers		
System stability	Expected gains.	• Curiosity	
Usability		• Learning	
Task workflow		• Idealism	
Workaround			
Resilience to contribute			
Resilience to communicate			

Table 4.2: Barriers, drivers, and workarounds identified in the exploratory study

These factors have been articulated as barriers, drivers, and workarounds to *engagement in use*. Barriers correspond to those elements that hindered engagement; drivers correspond to those elements that facilitated engagement; and workarounds correspond to those strategies that participants devised to keep contributing and, therefore, engaged.

The barriers for engagement identified correspond to system related issues.

- System stability refers to the server issues that manifested during the study

- Missing functionalities refers to those functionalities that were not implemented, such as communication means between translators

- Usability refers to the poorly designed interface

- Task workflow refers to the seemingly random way the system retrieved the tasks, which the users did not comprehend

In a similar way, O'Brien and Toms (2008) identified factors that hindered engagement, such as negative experience to emulate a real-life encounter, technology issues such as information overload and pop-ups, poorly designed communication tools that delayed feedback, and interruption management. The barriers identified in this study could be considered a combination of those barriers and the aggregation of other factors. However, since the findings, and my understanding of them, does not adhere to the same reflexive process, the distinctions among them and their description will remain as described above.

The drivers for engagement identified corresponded to Expected gains. Expected gains can be defined as the ways participants can render their collaboration into a beneficial experience.

- Curiosity (Reiss, 2004), refers to the initial motivation that drove participants to take part in the collaborative creation. In this case, the professor was curious and took the initiative to start a collaboration with the research group at the University of Trento;

- Learning refers to the outcome triggered from the experience that results from the application of participant's knowledge and expertise to complete the tasks;

- Idealism Reiss (2004), refers to the personal satisfaction that participants get when knowing that they are contributing to something that can benefit others.

Workarounds refers to the creative ways participants overcame the barriers to contribution which allowed them to continue with the tasks.

- Resilience to contribute refers to the strategy participants adopted to keep contributing because the collaborative system was not working properly.

- Resilience to communicate refers to the strategies participants adopted to communicate because communication between translators was not possible through the system and they did not use the system to communicate with the evaluator.

Moreover, from this study, the target community was identified as the students of linguistics because they found the experience very rewarding in terms of Expected

gains. The set of barriers, drivers and workarounds are further refined in the second phase described in the following section.

4.3 Perceiving problem and conceiving solution

the goal of the study was to evaluate a UI paper prototype while observing whether peer-evaluation would be a feasible option. To that end, another set of participants was involved. This time, participants were all students as from the previous study it emerged that they found the experience enriching, in terms of learning and usefulness. Participants were engaged in a paper prototype testing and in a focus group.

The focus of my analysis in this study was to refine the set of barriers, drivers and workarounds identified in the previous section while understanding whether the involvement of students in previous stages of the design would have an influence in their engagement.

4.3.1 Participants

Seven students were involved from two different universities: the University of Macerata and the University of Trento. On the one hand, to involve students in the University of Macerata, the same professor as in the previous study proposed a seminar to enrol participants. Five postgraduate students in Modern Languages for International Communication and Cooperation from the University of Macerata decided to collaborate. On the other hand, I was acquaintaned with a professor in the Department of Humanities from the University of Trento. She put me in touch with two of her colleagues: one from the Department of Languages and Translation and the other from the Department of Languages and Literature. I presented the project to several postgraduate students by offering the possibility to collaborate through a university seminar and, therefore, get credits and experience in participating in the co-design of a collaborative system of this kind. Three postgraduate students in Linguistic Mediation, Tourism, and Culture from the University of Trento decided to collaborate. In total, four female and three male participants, age range 21 - 25, decided to participate. Moreover, they had a good knowledge of English; therefore, they correctly responded to the requirements of the activity of translation.

Furthermore, the students' role in this study changed: for this study participants would have two roles instead of one, therefore, they would be translators and evaluators, evaluating each other's translations. In this way, the number of tasks a

single evaluator had to evaluate was reduced by involving as many evaluators as translators.

4.3.2 Data collection and analyses

An observer and myself collected the source data for the prototype testing session. We conducted two sessions where two sets of participants were involved: one group, Group 1, composed of four students gathered in the University of Macerata; and the other group, Group 2, composed of three students gathered in the University of Trento. Each session lasted around two hours.

To provide translations, two different compilation forms were proposed. The compilation forms were designed in a similar way to the steps they had to go through in order to complete a translation task in the online UI. Forms were printed and stapled so that different steps were presented on different numbered pages. Moreover, there were two different forms: one to translate a word into Italian (Figure 4.5) and another to be used when the word did not have a translation into Italian (Figure 4.6).

Figure 4.5: Paper mock-up used during the focus group. Used when there was a translation into Italian

Figure 4.6: Paper mock-up used during the focus group. Used when task was translated as lexical GAP

Moreover, we gave them three colour pens: blue for compilation, red to mark incorrect elements while evaluating, and green to mark the task as correct. Furthermore, we allowed them to use the computer to look for words but they were not allowed to talk among themselves. Only after the translation and evaluation of the tasks was completed did we allow them to talk.

During the prototype evaluation, we proposed different words to the participants to translate. More precisely, there were four rounds with three words each. We showed them words, one at a time, and they had to translate them and evaluate them. Once participants finished the translation of a task, all at the same time, exchanged the forms to have them evaluated. Only when all had finished the evaluation were translation tasks returned to their original author. Every student evaluated another student's translation tasks. A total of 72 paper prototypes were compiled and analysed.

After the testing session, a focus group was conducted with all the participants in each of the groups. The focus group lasted between 20 and 30 minutes. The aim was to understand:

- the complexity of the translation and evaluation tasks, and

- how they perceived the evaluation process.

Data was collected using four methods (Table 4.3): i) background questionnaire to obtain demographics of the participants; ii) Video-recording of the group evaluation session; iii) paper prototypes; and iv) audio-registration of the focus group. Findings were obtained from the triangulation of the video, focus groups and paper prototypes.

Method	Data source
Background questionnaire	7 participants' demographics
Video-recording of the evaluation process	12 videos. Group 1 had one video per round. Group 2 had two videos per round to facilitate file transmission from camera to computer
Paper prototypes	72 compiled and evaluated paper prototypes
Focus group	2 audio recordings and transcription

Table 4.3: Methods and data source for the co-design session

4.3.3 Findings

After completing and evaluating the translation of every word, students had time to reflect and comment with the group on their concerns about the task and the evaluation received. Rounds lasted between 16 and 25 minutes, approximately.

System failure

The study showed the importance of the task workflow to facilitate participants' communication in case of conflictive translations. For example, rather than marking a task in red, they could have discussed it, as they felt bad for marking a colleague's task in red. Also, when they all had different opinions, they could have solved the conflict by talking through some means of communication.

> Participant 4: *"For example with the word 'pannier' we would've been talking about* "what do you think?" *obviously confronting , sharing our ideas it is always better."*

Interestingly, when they wanted to communicate, participants found the way to do it by using the paper prototype, as prescribed in the task workflow. They wrote recommendations on the paper prototype on how to correct or improve a task, always using very respectful language such as "*I suggest a different gloss: borse laterali*" or "*I don't think it should be considered a GAP since we have the word 'paniere' which is the nearest concept in Italian that could be found.*"

Usability

Form design and organisation. The compilation was done following a sequential order, as presented in the paper forms. Most of the time, when compiling the POS, they translated it into italian. For example, all the words were nouns and they all translated 'noun' into the italian equivalent 'nome' or 'sostantivo'.

Using different colours produced a different impact on them. On the one hand it pushed them to be more careful and precise.

Participant 2: "*The idea of the red and green colours makes you aware that you have to work harder .. but in the end you have worked a lot, and you are working a lot.*"

On the other hand, using colours to evaluate a colleague was unpleasant for them, specially when the task was not correct and they had to use the red colour to mark a colleague's task.

Participant 4: "*I felt very sorry Participant 4 because it was the only time I marked wrong so I said " should I do it? Maybe he can accept it". That's why I asked you [me] should I do it.*"

Participant 3: "*It was very difficult to mark it red. It's like you did a good job but I think you are wrong.*"

Task workflow

Peer evaluation. Some students reported that being evaluated by a colleague was not meaningful and some preferred being evaluated by an anonymous evaluator.

Participant 6: "*I have to say because knowing that I and other people which are the same as me, are correcting me I don't feel that much corrected. Because knowing that I could be right or I correct someone I know I could be wrong so it doesn't have any actual validation.*"

Participant 5: "*I would've preferred if the person to correct would've been someone else, like an unknown person. Someone who didn't know me, who didn't know any of us and who could judge in an objective way. Maybe I make some mistakes but people who know me might not be so strict to mark it.*"

These testimonials showed the importance of anonymity when acknowledging the author of the task and the author of the evaluation, while highlighting the need for trustworthy and neutral evaluations to learn.

In the type of evaluation proposed, fast translators had to wait for slower ones. Also, when evaluating, fast evaluators had to wait for slower evaluators. Moreover, waiting produced a mixture of feelings: on the one hand, it made them wonder whether they completed the task appropriately whereas, on the other hand, it made them wonder why the evaluation was taking so long.

Participant 4: "*Maybe I'm wrong .. did I do everything?*"

Participant 5: "*Maybe I didn't write enough.*"

Participant 7:"*Why is it taking too long?*".

While the selection of peer evaluation could help the adoption of some measures to overcome some of the barriers identified in the previous study, such as reducing the number of tasks to complete, it highlighted other possible issues that might emerge, such as participants' hindrance.

Expected gains.

Learning. Participants, as well as in the previous study, found their contribution to be an opportunity to deepen their knowledge and understanding in their own language as well as in English.

Participant 1: "*It really helped to go deeper into your language, of both languages because you research them in a different way. You get to see all the nuances and sometimes you pull your hair because you ask yourself how do I do it.* "

Nonetheless, most of participants' experience was related to the use of corpora: large pieces of text where translations were produced considering words in context. For them, the translation of words in isolation posed a challenge.

Participant 2: "*You have to work a lot. After doing translations, but always on text, we don't focus on the description of a single word. You take it from the context, apply your knowledge about the Italian language and about the source language to produce a translation. It's hard to define an isolated word.*"

Participant 1: "*There are loads of nuances and I have to understand them all.*"

For this participants translating the definitions of common words involved an extra effort they did not expect. Considering their background, they had to adapt their knowledge and experience to complete the tasks proposed.

Participant 4: "*My first difficulty was to find a definition for 'name' because it's so common as a word that you don't even think about a definition for it. So when they ask, describe the word 'name' without using the word name, it is a challenging task*"

Idealism. Participants perceived the experience as contributing to a resource that in the future will benefit them and other translators in the community.

Participant 7: "*It is useful because you can learn. Starting from here, looking for the definition, word by word, task completion turns to be more precise. The problem is finding the right definition for the translation to describe something that you need to produce translations: we are chasing our own tail.*"

While Expected gains showed the importance of challenging student's knowledge and expertise to engage them in the task, the testing session highlighted the importance of viewing this experience as a new way to learn new skills and its outcome as a resource that would be helpful for them as well as for others.

4.3.4 Discussion

The following table, Table 4.4, summarises the factors that hindered and facilitated engagement identified in the prototype evaluation.

Barriers	Drivers	
System failure	Expected gains.	• Learning
Usability. Form design		
Task workflow. Peer evaluation		• Idealism

Table 4.4: Drivers and barriers identified in the second phase

Some of the factors identified in the previous study were also present here, whereas some others emerged. Two important aspects emerged referred to: i) the unpleasant feeling of correcting a colleague's tasks, contrary to what Kraut and Resnick (2011) proposes by claiming that receiving sincere feedback motivates participants, and ii) the need for anonymity, contradicting the importance of acknowledgment described by Rotman et al. (2012). Moreover, peer evaluation brought up other issues, such as participant hindrance, due to waiting for each other's tasks to be completed, as their progress depended on each other. Interest-

ingly, during the prototype evaluation, participants found a way to communicate possible improvements to the translations, using the paper prototypes where they wrote their feedback. Furthermore, participants had experience with corpora and felt challenged by the tasks proposed, engaging them. In general, they perceived their contribution to be very beneficial for them and for the co-construction of the linguistic resource which they already understood was something they and their community would benefit from in the future.

4.3.5 UI redesign

The redesigned UI emerged from the result obtained in the exploratory study, as well as in the prototype evaluation. Both UIs, for translation and for evaluation, were homogenous in visual terms. They were presented in Figure 4.7 and Figure 4.8, consecutively.

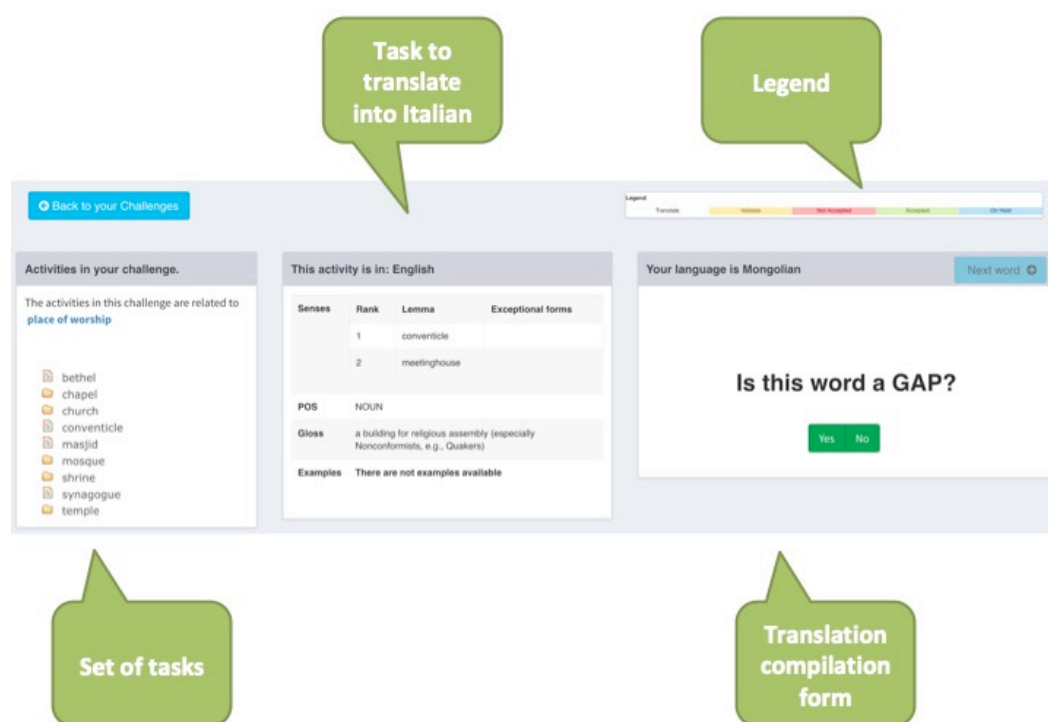**Figure 4.7:** Translator's UI composed of four modules

The left box contained the set of tasks, i.e. the English concepts, to translate or evaluate. The meaning of every word was shown by passing the mouse over them. When clicking on the word, the information related to that word is shown in the middle box. Therefore, that box contained the task to be translated or evaluated into Italian, with the English concept.
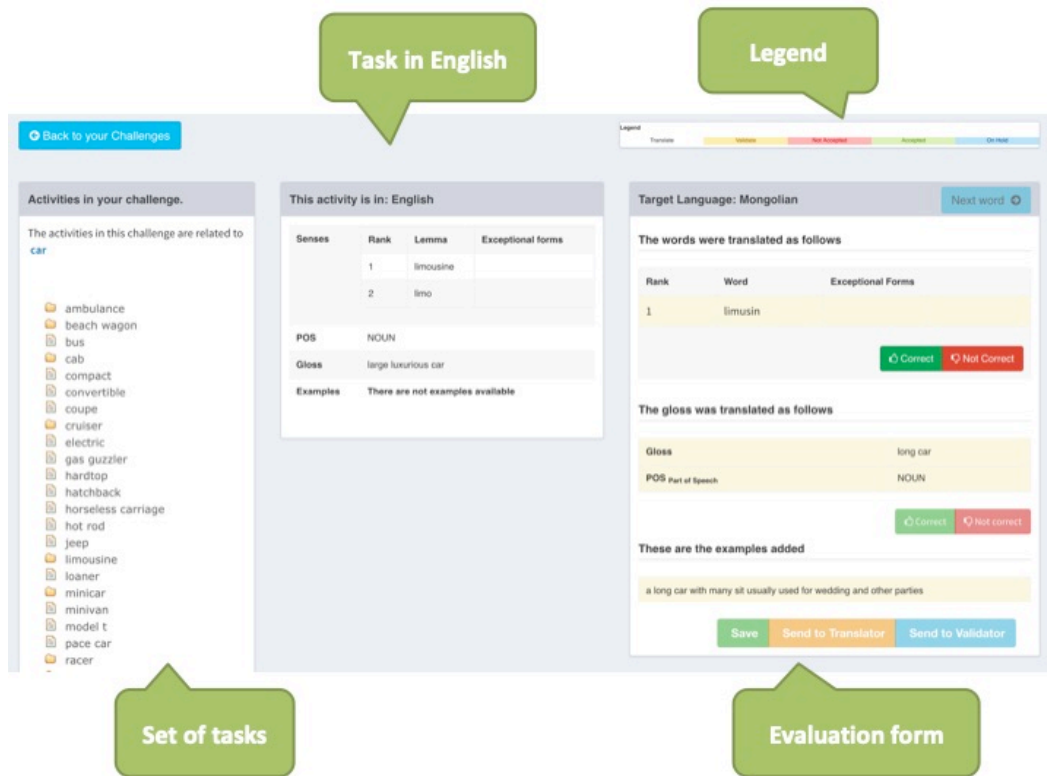
Figure 4.8: Evaluator's UI composed of four modules

Depending on the participant's role, the right-hand side of the screen would present the translation box or the evaluation box. The translation box was modified according to the feedback obtained from the prototype testing session so that, once participants decided whether the word had a translation into Italian or not, the same steps as in the prototype would have to be completed. The evaluation box was left as it was in the previous version as that was not evaluated. The button "Next word" retrieved a new concept to be translated or validated into Italian.

On the top of the screen, a box containing the legend was added to clarify the different stages of a task. When the activity was presented in white, it meant that it was ready to be translated; if the evaluator retrieved the task in yellow it meant that it was ready to be evaluated; if the translator triggered the task in blue, the task was waiting to be evaluated; if the activity was in red, it meant that something was not correct and the translator had to correct it; and if the activity was green, it meant that the task was correct.

4.4 Trying out and evaluating the solution

This phase aims at testing the new UI in a real-life collaborative system. To this end, the same set of students as in the second phase was involved. More precisely,

the evaluation involved four students from Group 1, at the University of Macerata, who were evaluating each other, and two students from Group 2, at the University of Trento, who were evaluating each other (in total, three female and three male participants, age range 21 - 25). From the testing session it emerged that participants were challenged by the tasks proposed, that they were concerned about evaluating their colleague's task and their anonymity, that the review process depended on their colleague's progress, that they communicated using the translation form, and, more importantly, they envisioned the relevance of contributing to the resource as they would be benefited in the future. The evaluation period lasted from mid October 2016 to mid December 2016. During that time, one of the participants in Group 1 had problems accessing the system, due to an earthquake in Macerata in late October 2016, and another participant in Group 2 had family issues so she could not engage. The aim of the evaluation was to test the usability of the new UI. The focus of my analysis in this phase, as well as in the previous one, was to consolidate the set of barriers, drivers, and workarounds refined in the previous section while understanding whether the involvement of students in previous stages of the design would have an influence on their engagement.

4.4.1 Data collection and analyses

Before the evaluation of the collaborative system started, I created the username and password for each of the participants and sent an email to each of them with their credentials so that they could access the system. Moreover, I selected and assigned sets of concepts for participants to contribute so that every participant had around 100 concepts to translate. Furthermore, diaries were distributed among participants, as they were in different regions of Italy and they could access the UI from anywhere. They were requested to annotate the date they used the UI; starting and finishing hour; issues encountered; thoughts; impressions; and feelings. Two months later three diaries, out of six, were collected.

Considering that, from the testing session, it emerged that waiting produced anxiety in students I decided that, to avoid that feeling in participants, translation and evaluation tasks would be assigned at different times. Initially, only concepts for translation were assigned, so that all of them had time to complete some tasks before starting to evaluate each other. Evaluation tasks were assigned three weeks later.

During the evaluation period, the participants and I communicated through email. The aim was twofold: to make myself "present" even though we were in different regions across the country and to engage participants with the system by notifying them of issues or information about the system. Emails were grouped

into three main categories according to their content: server notifications, questions/doubts, and general information.

At the end of the evaluation period, I distributed a questionnaire among participants via email to be completed online through Google Forms. The questionnaire was selected because participants were in different locations and some of them were not living near their universities. The questionnaire had three parts: background information, user experience questionnaire based on UEQ questionnaire (Laugwitz et al., 2008), and three open ended questions to collect information about different aspects or features of the system. The UEQ used a 7-point Likert scale to measure hedonic and pragmatic qualities of interactive products. It was selected as it is quick to complete and, through the 26 items, it offered a wide panorama on participants' experience. Moreover, the authors provided a tool to analyse the results obtained. Questions were grouped according to the dimensions measured by the questionnaire:

- attractiveness refers to the overall impression of the product;

- perspicuity refers to how easily is to get familiar with the use of the product;

- efficiency refers to the capability of a user to solve tasks without any extra effort;

- dependability refers to feeling that the user is in control of the interaction;

- stimulation refers to the excitement and motivation a user would feel while using the product;

- novelty refers to the innovativeness of the product.

Once the evaluation period finished, I accessed the log file of the system to analyse the number of tasks translated, the number of tasks evaluated, and the number of days they worked.

The triangulation (Olsen, 2004) of this rich data set (Table 4.5) was analysed to refine the set of barriers, drivers, and workarounds to engagement following a reflexive orientation.

4.4.2 Findings

By the end of the study they had translated a total of 250 concepts, and a total of 180 concepts were evaluated. Figure 4.9 presents the total number of concepts

Method	Data source
Diaries	3 participants' diaries
Emails	95 emails
Questionnaire	6 responses
Log file analysis	1 system log file

Table 4.5: Methods and data source in the evaluation

translated per participant and Figure 4.10 presents the total number of concepts evaluated per participant.

Figure 4.9: Tasks translated per participant. In blue, the number of concepts translated. In red, the number of concepts assigned.

As registered in the log file, during the two months of the study, participants contributed through the collaborative system for a total of 23 days. The speed of translating and evaluating tasks depended on the familiarity and complexity of the set of words. For example, one of the participants annotated in her diary that she translated 18 concepts in 65 minutes. Another participant was familiar with the topic she had to translate and it took her around 4.8 hours, distributed in three days, to translate 46 words.

During the study, not all the participants contributed in the same way: three of them translated almost all the concepts they had been assigned, while only Participant 5 completed his evaluation task. Participant 2 and Participant 6 had family issues and access issues due to the earthquake, respectively, which justifies
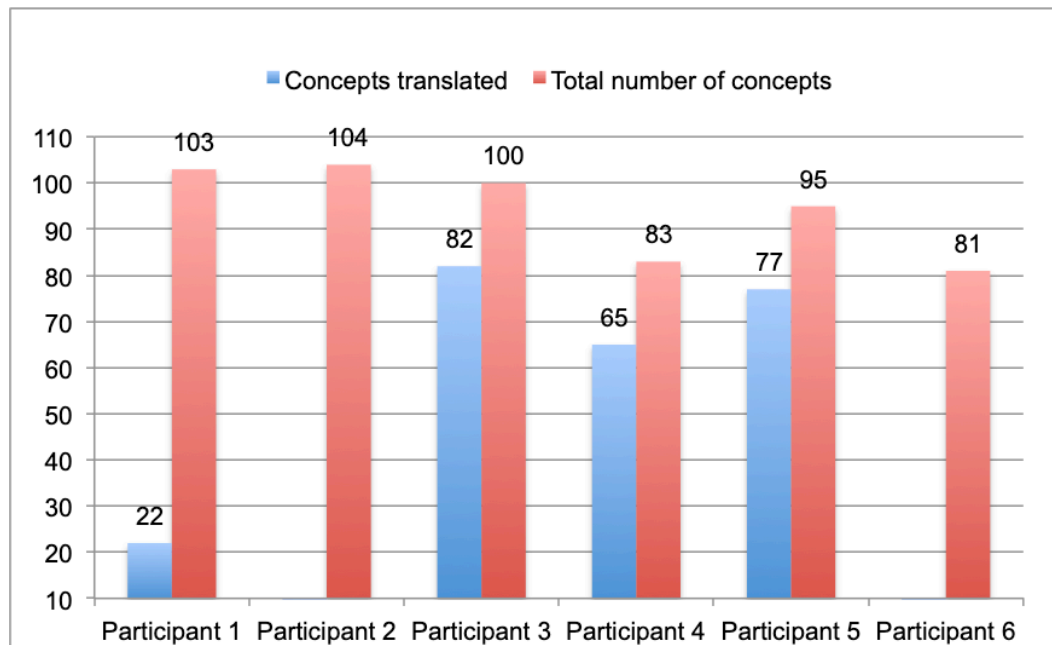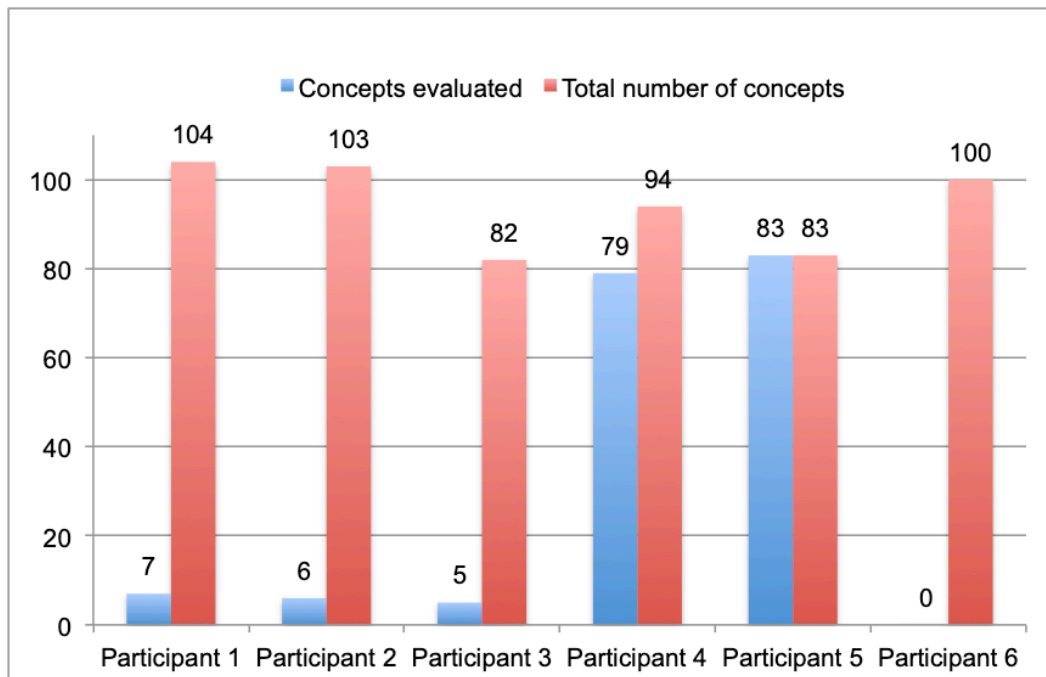
Figure 4.10: Tasks evaluated per participant. In blue, the number of concepts evaluated. In red, the number of concepts assigned.

their low contribution. The total number of concepts translated was 250, whereas the total number of concepts evaluated was 180 out of 566.

During the months of the evaluation I took an active role by keeping in touch with the participants and being available through email. Most of the time, I sent emails to all the participants and, from them, some individual exchange occurred. Other times, they wrote to me individually with questions or doubts. For example, I wrote in one email "*If something is not clear, please, contact me. I'm here to help :) and I'll be more than happy to do it.*". I tried to reply to their doubts as quickly as I could, reminding them about the use of their diaries. For example, in every email I reminded them to use the diary by adding a reminder at the end of the email as, for example, "*kind reminder: don't forget to write in your diary :)*" or "*... And don't forget to use your diaries.*" I also encouraged them and showed personal interest when the emergency happened in Macerata and when one of the participants did not reply to the emails. For example I wrote to Group 1 asking them "are you all ok?" to which Participant 5 replied: "*Here in Macerata we shake a little bit too much lately, I'm sure you've already heard about it, the situation looks a bit better lately but we'll see.*". Emails were classified into three categories:

- server notifications. In this case, I notified participants when the UI was not working or when the service was restored. On these occasions, participants replied by thanking me for notifying them; For example I wrote: "*Due to some maintenance problem, the system is not available. I will let you know as soon as*

the system is back." or "*The system is back to life! You can access it via the usual url.*" when the UI was accessible again. To this, Participant 6 replied "*thank you for notifying me*".

- questions/doubts. In this case, participants contacted me when they did not know how to proceed. For example when they did not know whether, after saving a translation, they had to send it to evaluation; or when they wanted to know if some functionalities were available. One of the participants was specially active and contacted me often when she had doubts about the system and about the tasks:

> Participant 4: "*After having completed a word with its definition, should we send it to validation or just save it in our records?*"

> Participant 4: "*Is there a way to count how many lemmas we have completed and how many we still have to do?*"

- general information. In this case, I notified participants when their evaluation tasks were assigned. Participants contacted me when they finished all the tasks they had to translate, wondering whether or not it was a server crash:

> Me: "*I have just assigned you your validation tasks. Each of you will validate one of your colleagues challenges. Bear in mind that, as validators, you very much depend on what your colleague, as translator, does. If the translator doesn't send tasks to validate, the validator won't be able to check the correctness.*"

> Participant 5: "*it looks like I've completed my challenges even though I can never be too sure it's not a system crash lol.*"

This effort to be virtually present, showing empathy and closeness, proved to be an effective way to build a trust relationship between the participants and myself; it was highlighted by their feelings of legitimation to make jokes about the system's crashes or suggestions on how to improve it.

System stability

Participants' contribution and the number of hours invested were hampered by the technical problems of the system. I had to notify them two times that the server was

down. The first time it took developers more than a week to find the problem and fix it. The second time it took three days. One of the participants wrote in the diary:

> Participant 4: "*After a few days, the system is again available online.*"

Although I tried to push the developers to have the issues fixed, very often their answer was that this system was not one of their priorities, and therefore its maintenance was reduced to the minimum. Through the diaries and the emails I could observe the different feelings they experienced. For example, when the system was not fluently working, Participant 4 expressed her frustration "*I give up, I feel frustrated*", "*the website stopped working . . . AGAIN!*", and her happiness when the system was working: "*The website today was fully working . . . finally!*". However, even though the system was hindering their work, they tried to be positive about their experience.

> Participant 5: "*It looks like I´ve completed my sets of words even though I can never be too sure it´s not a system crash lol.*"

Moreover, although participants found it to be a positive benefit that the system allowed them to work from home, they considered that its efficiency was very low and expressed their dissatisfaction by writing in the questionnaire that it was "*slow*" and that "*it doesn't work often*".

These testimonials showed the importance of a well functioning system, to facilitate contribution and prevent participant's frustration, even though, in spite of the difficulties, participants kept using it and contributing.

Usability

Form redesign and organisation. In the evaluation of the prototype, it emerged that participants translated the POS into Italian. However, the system allowed the selection of English POS even when the translation was in Italian. The possibility of translating the POS into Italian was discussed with the developers who decided to leave it in English as a way to standardise the classification of words for other languages. Moreover, in the exploratory study and during the prototype testing, participants noticed that very often the English concept did not include the example. While some participants claimed that sometimes it was complex to find an appropriate one, some others accepted that examples were needed, agreeing with the system developers who thought that keeping the introduction of an example as mandatory would be beneficial in the future.

Resilience to contribute. Sometimes, even though the server was working, during the translation and evaluation tasks, the website had stability problems and they could not continue with their activities normally:

> Participant 4: "*It takes a little time to evaluate the tasks. The most time is spent waiting for the website to work. When I try to access to the set of words, after a while it says that the set doesn't exist. It happens quite often.*"

> Participant 5: "*I have started classifying 'internal organs' but because there was a technical problem I had to stop working.*"

However, these issues disappeared by logging into the system again, making participants feel disoriented as they could not understand the reason for such a serendipitous circumstance:

> Participant 5: "*I don´t know whether you sorted it out already or it was just something random, anyway I get back to work!*"

These situations highlighted that, rather than feeling discouraged to use the UI, unlike in the exploratory study, participants were engaged with the system, showing their resilience to contribute.

Missing functionalities

One of the participants did not accept the set of tasks she was assigned, thinking that the system would retrieve another set for her. However, the system did not respond in the way she expected.

> Participant 1: "*I thought I could choose another set of words, I have clicked on "No thanks" instead of on "Accept" and now I can't either select that set or get another one.*"

Moreover, as previously mentioned, the system used a Depth First Search algorithm to retrieve concepts. When the algorithm reached the end of the last branch, the system blocked it and participants could not revisit the tasks they wanted to review.

> Participant 5: "*As I finished my work I wanted to go back to the tasks I skipped but the system tells me I have finished my set of words and doesn´t*

let me get into the section internal organs anymore :(hope it is something we can fix."

I discussed with the developers the possibility of including a back button, so that the algorithm could move backwards in the set of concepts. However, the inclusion of such a button in the UI would imply the implementation of a very complex algorithm to identify the father of a given concept, and that would have a very high cost in terms of time and number of calculations. Furthermore, participants asked whether there was a way to visualise the number of tasks completed and the number of tasks that were left:

> Participants 4: "*Is there a way to count how many lemmas we have completed and how many we still have to do?*"

The visualisation of the progress was requested by participants in the exploratory study. However, when implemented, it made the system even slower, because accessing all the tasks in a given set to check their status made the system slower. Because such functionality was not available, some participants decided to write down the words they were translating so that, knowing the total number of tasks in the set, they could know the number of tasks left. This I called **resilience to missing functionalities**. Very often they expressed their uncertainty about the number of tasks completed.

> Participant 5: "*I've done some more words. I'm enjoying it but I'm not sure how many I did or whether I finished the set ´Internal organs´.*"

Task workflow

The real-life evaluation highlighted that the number of steps a task had to go through affected the efficiency of the system. The fact that participants had to return to the task a second time was not intuitive:

> Participant 4: "*After having completed a word with its definition, should we send it to validation or just save it in our records?*"

Some of them commented in the questionnaire: "*[the system] doesn´t let you save and send to evaluation one word in the same session (you always need to close and open the page again)*" or "*you need to go through all the translated words every time you access to the set of words assigned*". While this issue was observed in the exploratory study, it was highlighted in the results of the questionnaire. In Figure 4.11 the grey

columns represent the mean values for each of the dimensions whereas the black lines represent the standard deviation of the values for each of the dimensions. As shown, the efficiency of the system was classified as low, whereas dependability, stimulation, and attractiveness had higher mean values.

Peer evaluation. The feasibility of the peer evaluation process depended on the dedication of both parties: translator and evaluator. Although the evaluation tasks were assigned three weeks later than the translation tasks, it created some conflicts among those who wanted to finish the evaluation tasks faster and those who were slow in translating: the former ones translated their words and wanted to evaluate their partner's words. However, if the latter did not complete any translation, the former could not progress and, therefore, finish.

> Participant 4: "*I only had to evaluate less than 20 tasks should I expect others to appear? Or may I consider my job completed?*"

While their progress was constrained by their colleague's progress, they highlighted their experience of contributing as a chance to learn and work with others by writing in the questionnaire: "*Possibility to compare with other participants*" and classified the system as "*cooperative*".

In the first version of the UI, participants with an evaluator role could know who translated a specific task by passing the mouse over any of the components of the task. I discussed with the developers the possibility of not showing it. However, they emphasised its importance so that, in case of plagiarism, it would be easy to acknowledge who compiled the task. Nevertheless, this feature was not obvious to participants. I will illustrate how it became important for them through two examples:

Example 1. Before I entered the project, a member of the research group tested the system by translating tasks. However, the concepts were wrongly translated and sent to evaluation. During the translation, some participants encountered some of these concepts which confused them:

1) when translating concepts, they realised they had completed less tasks than they had expected.

> Participant 4: "*There were less tasks to be translated than what I expected to be. I just wanted to be sure that I didn't miss anything, so let me know whether I was wrong to count them or what I am supposed to do next.*"

Participant 3: "*I want you to know that some of my lemmas have been sent to evaluation but I didn't do that.*"

2) When evaluating, they could see that some concepts had been compiled by someone else. Such concepts lacked definition and example. Some participants thought that the tasks were compiled by an irresponsible translator:

Participant 4: "*Some of the tasks were correct, some others were wrong because they were incomplete (no gloss, again): it seems that the translator I've been asked to evaluate is a bit lazy.*"

However, once they realised they could see the author of the task, they used this feature to understand where the issue came from.

Participant 3: "*I was looking at the evaluation task and I have accepted the Internal organs one and I have both words submitted by "someone" and Participant 5. What "someone" has done is lacking of glosses and examples, what should I do? Should I mark them as not correct and send to the translator?*"

Example 2. The utility of acknowledging who compiled a task came up when participants could not keep evaluating due to the lack of tasks submitted. Initially participants did not know who the translator was.

Participant 4: "*I would love to push the translator to be quicker in his job, but unfortunately I don't know who the translator is. I'll be patient anyway.*"

However, they realised the importance of knowing who the translator was when trying to understand why they were not getting tasks to evaluate.

Participant 4: "*It seems that I found who my lazy translator is, since I understand I am evaluating (or not evaluating, should I say) his translations.*"

In these two examples, participants, who were initially reluctant to leave their trace on the collaborative system, found the utility for acknowledging tasks to understand why they had less tasks than expected and to know who the person was whose tasks they had to evaluate. While showing a better understanding of the functionalities of the system from the participant's side, this highlighted the responsibility they felt for their piece of work.
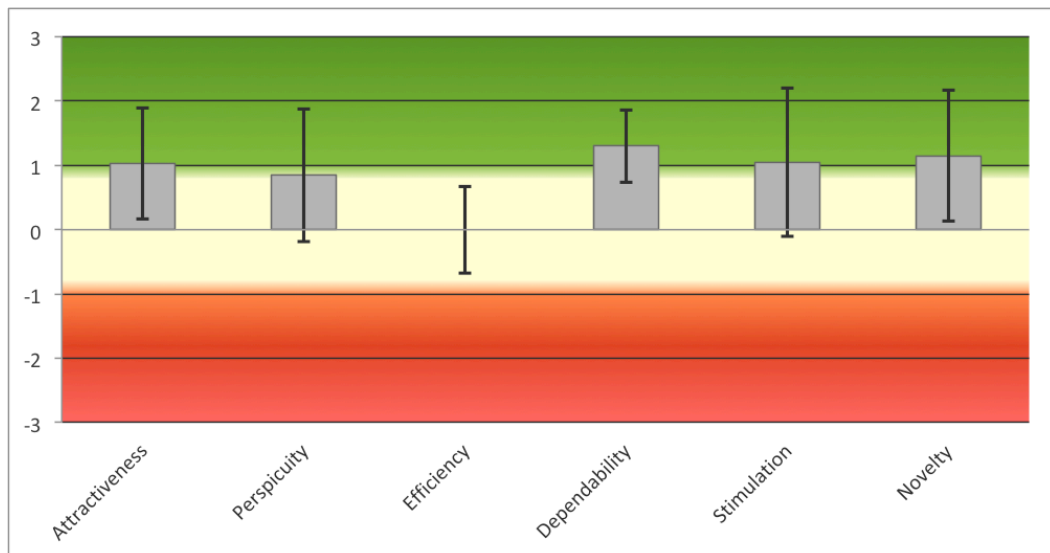
Figure 4.11: Graphical result of the questionnaire

The possibility of updating the task workflow was discussed with the developers' team. The change proposed involved the submission of tasks to evaluation or return to translation in only one step. This would increase the system's efficiency and the number of concepts translated and evaluated. However, the suggestion was not accepted as, according to the developers, the idea behind the task workflow was that saving the task would facilitate its review and improvement before submitting it to the next step.

Expected gains.

Learning. Participants showed their enthusiasm and commitment to the tasks they had to translate and how challenging it was for them:

> Participant 5: "*I was enjoying learning so many new medical things.*"

> Participant 4: "*I've been working the whole weekend on the tasks that you gave me.*"

According to the participants, some sets of tasks were easier than others, depending on the familiarity of the user with the concepts. One of them wrote in the questionnaire that tasks were "*linguistically challenging*". All participants engaged with their translation tasks:

> Participant 4: "*I liked the second set of tasks more since the linguistic field is closer to my personal experience.*"

Participant 5: "*The specificity of words I had to translate made me doubt of my skills and knowledge of my language!*"

Participant 5: "*I´ve worked on the system today and as the first tasks of the section "internal organs" were particularly tricky I skipped them to work on the next ones and come back to those later on.*"

Nonetheless, they took the experience as an opportunity to learn more vocabulary and improve their skills. One of them wrote in the questionnaire "*Useful experience for a language student because it challenges your skills and helps you improve your vocabulary.*" while other participants wrote in their diaries:

Participant 3: "I am really enjoying my muscles task, it has been not easy sometimes but I'll get through it!"

While revealing the influence of challenging tasks in their enthusiasm about contribution, these testimonials highlighted that learning and curiosity were an important motive for participants to contribute.

4.4.3 Discussion

The following table, Table 4.6, summarises the factors that hindered and facilitated engagement during the evaluation. Some of the factors identified in the previous study were also present here, whereas some new ones emerged.

Barriers	Drivers
System stability	Expected gains. • Learning
Missing functionalities	
Usability	
Task workflow	
Workaround	
Resilience to contribute	
Resilience to missing functionalities	

Table 4.6: Barriers, drivers, and workarounds identified in the third phase

During the evaluation, the technical problems identified in the exploratory study persisted. Participants showed their frustration and their enthusiasm according to the functioning of the system. However, differently from the previous study, this time I was in charge of contacting them directly when the problems appeared, as

well as when the system was working again. Participants waited patiently for me to notify them so that, once the system was running, they kept contributing through the UI. Moreover, and contrary to what happened in the exploratory study, participants contacted me, the person responsible for the system, instead of the professor, when they had doubts about task completion as well as the system's usability. Therefore, a trust relationship was established between us by creating closeness and availability to avoid the feeling of abandonment in spite of the distance. Furthermore, participants used the means provided by the UI to communicate through tasks, as they did during the co-design session.

The missing functionalities, the order in which tasks were retrieved or the strange way the system worked at times, made them feel disoriented and that was reflected in the classification of the system as inefficient. Still, rather than feeling discouraged, participants kept using the system to contribute. One of those missing functionalities that was also present in the previous study, was the availability of a counter. Participants found their own creative ways to overcome the lack of a counter by writing down in the diaries the words they translated.

The feasibility of the peer evaluation depended on the dedication of both parties, translator and evaluator, which, at the same time, was considered a positive aspect as it allowed cooperation among them. Moreover, although this proved to be a reliable solution to reduce the number of tasks a single evaluator had to evaluate and a part of student's learning, some of them showed their discomfort when they did not get the tasks to evaluate or when they realised they were getting tasks from someone else. This was the moment when they discovered the usefulness of acknowledging a task, something that, initially, they were reluctant to accept.

4.5 Consolidating barriers, drivers, and workarounds

To investigate the factors that hindered or facilitated engagement in the co-design of a collaborative systems, in this Study I reflected on the information collected through a variety of data in the different phases, Table 4.7.

In this section I reflect on the set of factors that hindered or facilitated engagement that were articulated in the exploratory study as barriers, drivers and workarounds, that were refined in the second phase of the research process, and that, in this section, is consolidated by comparing both studies.

Phase	Focus	Participants
Exploring and defining the problem	To understand what factors hindered or facilitated engagement in this preliminary phase	6 participants
Perceiving the problem and conceiving solution	to refine the set of barriers and drivers identified in the previous section while understanding whether the involvement of students in previous stages of the design would have an influence on their engagement	7 participants
Trying out and evaluating solutions	To consolidate the set of barriers and drivers refined while understanding whether the involvement of students in previous stages of the design would have an influence on their engagement	6 participants

Table 4.7: Focus of the analyses in the different stages of the research

The study started by involving a set of participants, who were students, and an associate professor of Linguistics in the evaluation of a preliminary version of the UI. In this exploratory study, a set of factors to facilitate and hinder engagement emerged that were articulated into barriers and drivers. Interestingly, participants showed creative ways to keep contributing when specific barriers emerged: those were identified as workarounds. From this exploratory study, the target community was identified as the students who found this experience an unexpected gain as it would be an opportunity to improve their linguistics skills. However, the evaluator was overwhelmed as she had too many tasks to evaluate. In the next study, a new group of participants was involved; this time only students were considered and had two roles, so that there were as many evaluators as translators. This set of participants was involved in a paper prototype testing, a focus group, and in a real-life testing of the collaborative system. During the testing, new barriers emerged related to the new roles assigned to participants and to task acknowledgement. In the evaluation, the former remained whereas the latter was not considered a barrier. Moreover, different workarounds emerged to overcome the barriers found while contributing. The following paragraphs describe each of the components of the set presented in Table 4.8.

Barriers	Drivers	
System stability	Expected gains.	• Curiosity
Missing functionalities		• Learning
		• Idealism
Usability	Unexpected gains. Opportunity	• Appropriation
Task Workflow		• Legitimacy
		• Freedom
Workaround		
Resilience to contribute		
Resilience to communicate		
Resilience to missing functionalities		

Table 4.8: Barriers, drivers, and workarounds consolidated in this study

4.5.1 Barriers

In this study, the digital system that participants had to *engage in use* in order to co-create a linguistic resource was not working well. However, the system challenged participants' resilience to *engage in use*. The server failed several times and it was not running for several days in both studies. Moreover, the website presented different issues that hindered users' contribution. Furthermore, the way tasks retrieval was not clear to participants. It seemed that, far from engaging participants, the collaborative system was designed to disengage and discourage them. Nonetheless, contrary to Bratteteig and Verne, 2018 who claimed that systems should adopt participants' practices, in this system, participants had to adopt to the way the system worked finding their own strategies to overcome the missing features.

4.5.2 Drivers

In spite of the unsolved system failures, participants showed an incredible endurance and resilience to the many obstacles they had to face during the period they were contributing. They understood their participation as an opportunity to collaborate between themselves and learn while *engaged in use*. Participants were Linguists, they were passionate about languages, and this system challenged their linguistic experience in terms of knowledge acquisition and knowledge application.

The difference in linguistic experience was turned into an opportunity and it was, at the same time, the motor that challenged them to engage with the tasks. Therefore the Expected gains were responsible for the engagement of participants. However, in this section I want to reflect on the Unexpected gains that emerged after the reflexive analyses. Unexpected gains refer to the unpredicted intrinsic benefit that a participant might obtain from *engaging in use*. In particular, in this study it was articulated as Opportunity, referring to the nature of the study: students started the collaboration through a university seminar which would provide them with credits. Opportunity led to appropriation, legitimacy, and freedom of the design space.

In the exploratory study, even though I explained to them that the aim of the study was to evaluate the UI and not their knowledge, and admitting that I was a student like them, I could notice, in some of them, their feeling of anxiety in the beginning of the think-aloud session. Moreover, some of them did not admit that they were using a word file instead of the UI. From those who admitted it, I noticed that some showed their discomfort when confessing it while others were very determined to declare they were using it because the system was unstable. After this experience, in the next phases I tried to be more involved with participants; using a respectful but informal language when communicating; and making myself available by using email as the communication channel and as a medium to elicit engagement while creating a trust relationship. Positioning myself closer made them feel legitimate to make jokes about the system's failures; to contact me when they had doubts rather than asking the professors who facilitated the collaboration, and to suggest new functionalities that were missing and essential in a system of this characteristic, showing how they were appropriating it. They freely expressed their feelings of joy when the system was working and their frustration when it was not working. Participants took ownership of their piece of the collaborative system by feeling responsible for their tasks as evaluators and as translators (Østergaard et al., 2018).

Furthermore, as shown in Figure 4.12, participants in the second and third phases outperformed participants in the exploratory study: the total number of concepts translated and evaluated in the second study were significantly higher. The exploratory study was conducted over three months while the real-life evaluation was conducted over two. Although both groups of participants were committed and engaged through challenging tasks, only one of them was *engaged in use*. This make me conclude that in the exploratory study the problems with the system forced participants to disengage, as classified by O'Brien and Toms (2008), and find an alternative in order to complete their tasks, while the second study shows greater *engagement in use*. This highlights that maintaining a relationship by being in touch with the person responsible for the system might have had an influence on their engagement.

4.5.3 Workarounds

Participants showed their creativity in finding their own strategies to overcome the barriers imposed by the system. The three workarounds identified were the result of participants' attempt to overcome the barriers that hindered their *engagement in use*. Workarounds depend on the circumstances in which the study was evolving, on the barriers, and the participants.
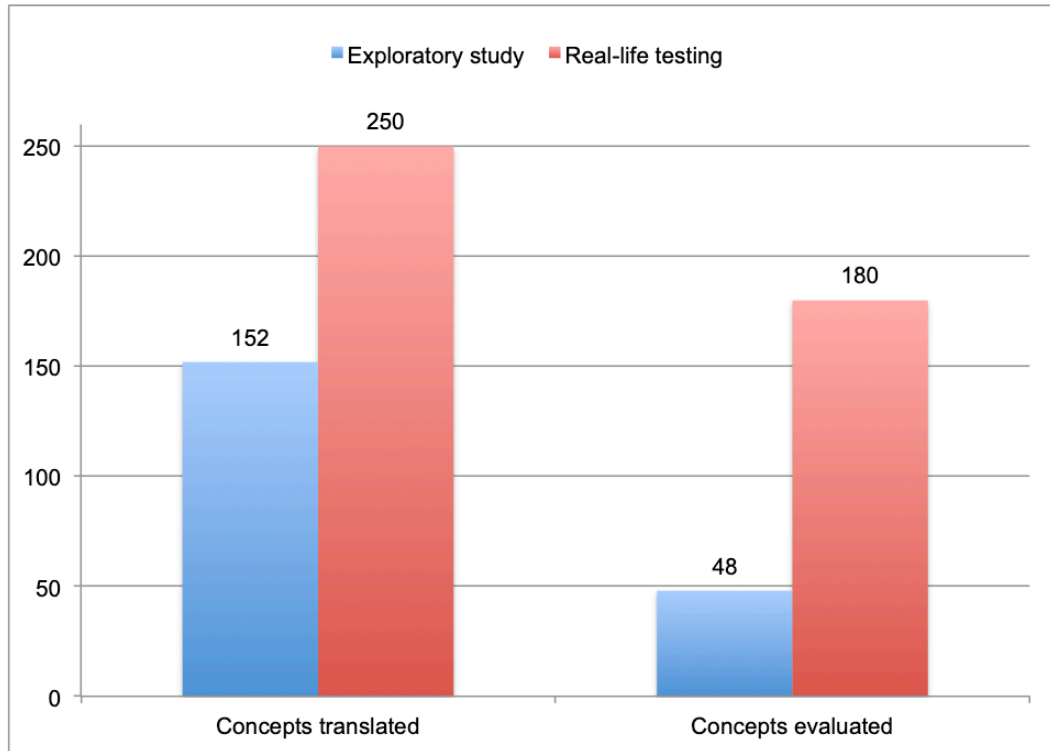

Figure 4.12: Concepts translated and evaluated by the two groups invovled

4.5.4 Remarks on the design space

During the time of this investigation I collaborated with the team involved in the co-creation and maintenance of the linguistic resource. This last paragraph describes my reflections once this collaboration finished. After conducting each of the studies, a list of measures to overcome the barriers was designed and discussed with the developer's team. Several of those measures were accepted and implemented. However, some others were not implemented:

- because they were going against the guidelines of the system, such as the optional introduction of the examples

- because they would make functionalities redundant when referring to the introduction of alternative ways of communication

- because of the complexity they would introduce to the system as, for example, with the statistics

- because they implied deep changes in the logics of the system, requiring human resources, and important changes in the system.

In this situation I found myself dealing with the two groups of actors involved in the study. On the one hand, I tried to explain to the system developers the concerns of the participants even though these concerns were dismissed because of technological limitations. Moreover, alternative solutions were not accepted either, such as using a parallel system, less complex, to facilitate contributions and then transfer those contributions to the Italian linguistic resource. Therefore, participants had to adapt to how the system worked rather than adapting the system to the participants' needs. On the other hand, I had to justify developers' decisions when participants experienced the complexity of the system that should have been transparent to them, which had, instead, made them more confused. I felt unable to make developers understand that the participants' opinion was as important as theirs and that their engagement was crucial for the creation of the linguistic resource.

Study 2

The second study of this thesis investigates *engagement in the design* in the co-design of an online repository to store educational materials. The study aims to validate the set of barriers, drivers, and workarounds identified in Chapter 4. This chapter starts by describing the sociotechnical background of the study. It then identifies the target community and the problem in several steps. Next, a co-design session is conducted resulting in different solutions to the problem. Finally, an evaluation of the prototype is conducted.

5.1 Background

This section frames the sociotechnical context around the online repository that this study reflects upon. This study locates itself in Trentino, a region in Northern Italy. Trentino has an autonomous status and enjoys a large degree of autonomy over different areas including health, education and welfare. More precisely, in the education area, the local government approved a Law in 2014 to make mandatory the adoption of a multilingual approach to teaching. More concretely, the policy foresaw the adoption of i) two foreign languages, English and German, and ii) the content and language integrated learning (CLIL) methodology by which, as well as learning the English and German languages, subjects that were previously taught in Italian would be taught in English or German. The law also established the minimum number of hours in which either of the languages mentioned above should be taught: three in the early years and five from third to fifth grade. Moreover, the government promoted measures for the good implementation of the law. For example, it offered teachers an adequate level of instruction to teach Italian children in a different language by promoting courses to update their practices; it enhanced the implementation of good practices, with a particular focus on digital applications; and it promoted the use of digital platforms and technologies with two aims: to support teaching and to develop teachers' networks. Furthermore, the law had to be followed and reflected in the schools' study plans and should be gradually introduced in all the grades of the primary school.

As in the previous study, this research was carried out within the Department of Information Engineering and Computer Science at the University of Trento. The

activities presented were developed within the InterAction Lab. The InterAction Lab was composed of 14 members from different fields, including computer science, sociology, anthropology, and design. The lab focuses on three main areas: public, inclusive, and aesthetic design. Currently the group is composed of seven members.

The study presented here is part of a long-term study in which members of the InterAction Lab engaged with different regional schools in Trentino. Several interventions took place, wherein different actors such as teachers, parents, policymakers, and educators were involved (Menendez-Blanco et al., 2017) (Menéndez-Blanco and De Angeli, 2016). Specifically, as part of the long-term engagement, members of the group could witness the impact of the law on teachers' practices. To know more about this, when I joined the group, I adopted an active role and focused my research on teachers' practices, the creative ways in which they tried to adapt to the new policies and their relationship with digital technologies. In this study, different collection methods were used, according to teachers' constraints. The activities presented in this case study have been developed in two educational institutions located in the two most populated divisions of the city.

5.2 Exploring and defining the problem

The first phase aims at identifying the target community and the problem around which this investigation will revolve. This phase is divided in three steps. Step 1, involved two rounds of interviews to identify the target community and the problem. Step 2 involved a focus group and a prototype testing session to refine the problem. Step 3 involved a last round of informal interviews to consolidate the problem addressed in this study (Figure 5.1). My analysis focuses on the initial steps of the engagement process.
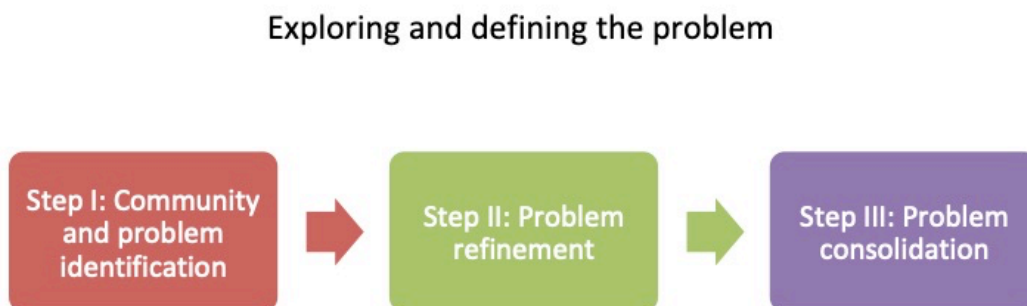
Exploring and defining the problem

Figure 5.1: Steps followed in this phase of the study

5.2.1 Step I: Identifying the community

The first step of the study was aimed to identify the community and understand teachers' practices, more precisely their creation, re-use, and sharing practices. In the study, two schools, from two different educational institutions, were involved: School A and School B. In the two schools selected for our study, there were two different multilingual approaches to teaching that followed the CLIL methodology and that I will refer to as projects. On the one hand, School A implemented the CLIL project in five of its ten classes from grade one to grade five, whereas the other five classes were integrated into the Bilingual project. They differed in the number of hours dedicated to teaching in a foreign language and the number of years they had been implemented in this school. In the CLIL project, three to eight hours were taught following this method, whereas in the Bilingual project 18 hours were taught in a foreign language. Moreover, the Bilingual project started in the academic year 2005/2006 whereas the CLIL project started as a pilot in the academic year 2009/2010 and was adopted extensively in the academic year 2015/2016. On the other hand, School B implemented the CLIL project in all its classes from the academic year 2015/2016.

Participants

Participants in the study, in Table 5.1, were selected following the snowball sampling methodology (Biernacki and Waldorf, 1981). I was acquainted with two primary school teachers, one from School A and one from School B, who put me in touch with their colleagues.

All the interviewees were female. They were selected considering the grade they were teaching, at least one per grade, and their years of experience: more than 30, between 29 and 20, between 19 and 10 and less than 10. Their age range was between 30 and 59, and the average number of years of experience in School A was 20.75 ($SD = 10.9$) whereas in School B it was 15 ($SD = 3.74$). All except one were Italian and one of the teachers in the study was the coordinator of the Bilingual project in School A. Three of the teachers were teaching in the Bilingual project and five were teaching in the CLIL project. Interviews took place in the two schools where the teachers worked.

School	Pseudonym	Age	Experience	Project
School A	Mrs. Blue	45 - 49	22 years	Bilingual
	Mrs. Pink	40 - 44	17 years	Bilingual
	Mrs. Grey	55 - 59	35 years	Bilingual
	Mrs. Green	30 - 34	9 years	CLIL
School B	Mrs. Brown	35 - 39	11 years	CLIL
	Mrs. White	40 - 44	15 years	CLIL
	Mrs. Red	45 - 49	20 years	CLIL
	Mrs. Yellow	35 - 39	14 years	CLIL

Table 5.1: Demographic data of the participants

Data collection and analysis

To identify the target community, primary school teachers' practices were investigated through the analyses of an interview designed to elicit their reflection on instructional material creation, reuse, and sharing practices.

Moreover, I collected school policies, by asking the school principal, and different policies at a national and local level, which were publicly available at the national ministry and local government's websites. Furthermore, I collected the minutes of the meetings related to the multilingual policies, which were also publicly available on the local government's websites. I analysed policies for educational institutions in the Northern region in Italy, and the policies that rule schools' activities as well as teachers' practices. Additionally, I took field notes in one of the schools where teachers created an archive to deposit instructional materials to be re-used and adapted by other teachers in the same institution. More precisely, I spent 28 hours in that school, 25 of them I spent in the teachers' meeting room examining the tangible materials, the archive where they store them, and a digital archive where they also store materials; one hour observing how two teachers prepared materials; and two hours in one of the teachers' classes inspecting more materials and the technologies available in the class. This included observing, asking questions and taking pictures. A summary of the data collected is presented in chronological order in Table 5.2.

In order to identify specific themes related to understanding teachers' practices and how technology was intertwined with them, I retrospectively analysed the data collected. Interviews were transcribed, stored and managed using Nvivo software. Thanks to this reach data set the identification of the two main themes, described in Table 5.3, and the issue of this study was possible (Silverman (2013)).

Method	Data source
Semi-structured interviews	8 audio recordings and their transcription
Observations	28 hours. Photos and field notes
Semi-structured phone interviews	8 audio recordings and their transcription
Document analysis	Field notes, National study plan, Provincial study plan, two school study plans, one set of guidelines on teachers' regulation, two publications on teaching in the bilingual project, and 26 study plans. All the documents are available on official websites

Table 5.2: Data collection methods and data sources in chronological order

Themes	Description
Adoption of new practices	The theme relates to the identification of new practices brought about by the new policy. These new practices emerged to better support teachers in their adaptation to the changes
Adaptation of existing practices	The theme relates to the various ways in which teachers had overcome the lacks and difficulties brought about by the new policy through creative ways or their own strategies

Table 5.3: Main themes identified in understanding practices

Findings

The adoption of multilingual approaches to teaching proved to be challenging for teachers as new practices were introduced, testing their resilience and capability to adapt to disruptive measures. While reflecting on their work, technology emerged intertwined with their working practices to support their activities when required. In this section, I describe teachers' reflection on the adoption of new practices and the adaptation of their practices to a new reality brought about by the implementation of a new policy.

A. Adoption of New Practices

The adoption of the CLIL methodology brought new strategies to support teachers and the students in their academic path. Two of those strategies were *co-teaching* and *co-presence*. In co-teaching, the mother tongue teacher and the English teacher were actively involved in the preparation and creation of materials as well as in the

instruction. *Co-teaching* was proactively proposed by the teachers in the Bilingual project as a way to innovate and experiment with multilingual teaching. They selected Maths because it was a subject traditionally taught in Italian. In School A, co-teaching was gradually adopted by all the classes, while in the other schools *co-teaching* was not adopted. Both teachers shared the same level of responsibility and, usually, they divided the tasks to be done during the class according to the skills of both members.

> Mrs. Blue: *"We share and collect the materials. As I'm Italian, I have more experience and know the Italian study plans and the methods to teach Math. Together we decide the activities to do and then we produce the materials: a bit her [the English teacher] a bit myself. We share the responsibility."*

Differently, in *co-presence*, the English teacher prepared the materials and led the class, whereas the mother tongue teacher was present to provide support when needed. Study plans foresaw their cooperation but not the mandatory presence of both of them in the class. However, teachers decided that the two of them had to be present in at least one subject to better support the students. Usually, teachers in the CLIL project followed this strategy in subjects such as Science or Geography, depending on the academic grade.

> Mrs. Yellow: *"I do co-presence in Geography which is taught following the CLIL methodology, and I also support the practical part of the New Technologies class. She [the English teacher] manages the class as she has linguistic skills to propose the activities."*

Some teachers took advantage of this strategy by involving the teacher in co-presence in those subjects where their presence was more valued. The teacher in charge of the class would decide who, among her students, needed support and in which subject.

> Mrs. Green: "*At the beginning of the year when we do the timetable, as we know children are in year five now and we know the class needs, we would say 'ok, in this particular subject, this child needs particular support' so that the colleagues who have the extra hours for teaching for supporting 'ok, I can do this I can be with you for this lesson for the rest of the year'. And that's how a lot of the support is defined."*

Study plans also encouraged teachers to work in a cross-curricular way. In this way, topics could be presented in different subjects from different perspectives instead of focusing on the content to be taught in every single subject. In this case,

teachers needed to gather, coordinate and share decisions on how to approach the topic to better present it to the students.

> Mrs. Yellow: "*In History, we studied the Egyptians. For example, in the Art class, and in the English class they did the hieroglyphs, they created papyrus with the hieroglyphs. Then also, in Italian, we covered some historical texts about the Egyptians. In New Technologies they researched more materials about their history. Different points of view about the same topic provide continuity. However, this is not always possible.*"

However, it was not only during classes that teachers worked in a cross-curricular way and collaborated. Out of their subjects and teaching programmes, teachers proposed new topics and conducted new projects with colleagues from different classes and grades.

> Mrs. Green: "*We also tend to do things outside of the very specific subjects. Sometimes you say shall we do a mini-project like a particular festival or even like in spring at some point we all said why don't we do a go-green activity with our classes where we would ask them to bring a plant take them out, and so on. Other time we would do something that is maybe a bit more language focused like doing shared reading, PET reading between classes and with different age groups. Sometime we would do like we did in the past we did it for Halloween and then collaborating with colleagues from the other department with a different class.*"

B. Adaptation of Existing Practices

Creating materials. Study plans enhanced the creation of original educational materials. They could also be homework for the students. Moreover, after the adoption of the multilingual approaches to teaching, teachers had to create their own instructional materials, as there was a lack of teaching resources in English or German to teach Italian children.

> Mrs. Green: "*For geography I find it to be more difficult I ended up reading and sourcing using Italian resources and then adapting it to English. Sometimes, because there is specific terminology, we would ask each other*

However, teachers claimed that CLIL methodology hindered the academic path of many students, especially those with learning difficulties. Often they complained that there were not enough resources for all the needs of the class. Still, they had created their own inclusive strategies to facilitate the learning of all the children in their classes by creating their own toolkits.

Mrs. Grey: "*Students with Specific Learning Disorders do not have support teacher. So I'm alone, what can I do? I decided to build a set of written instruments in capital letters, with designs linked to songs or sounds and I gave it to all the students in the class. After, some of them manage without the set of materials and decide not to use it. Those with difficulties use it for a period of time. That's ok too. Those with difficulties that can't manage without it, use the set always. That is, diversity is not in the construction of something different for you, but to create instruments that could work for all of them. I give the instruments to all of them, learning that we have different timing. I have told them 'let me know' " teacher, I will not use it today', and that's ok, do you understand?.*"

In the process of adaptation and creation, teachers used digital tools that they had in their computers such as Word, PowerPoint, applications for image manipulation, and the creation of videos, such as Windows Movie Maker. Moreover, they created homework, plans or study sheets using the previously mentioned tools. They also created many physical materials from printed photocopies or by building them with the available resources. These physical objects included science models, collages, or plastic boxes that contained materials.

Reusing materials. When teachers prepared the instructional materials for the next class, they usually looked for additional information. They turned to two main sources: i) online repositories, and ii) peers, with whom they meet casually or in planned meetings, and were considered a valuable source of knowledge and experience.

Mrs. Green: "*I would say that colleagues are valuable as resources as I said just being able to talk and exchange ideas and share.*"

When looking for instructional material online they made sure there were no licensing problems.

Mrs. Blue: "*The materials I look for are open source, and if they are not, I leave them where I found them. That's how it is.*"

Mrs. Green: "*What happens most of the time is I look for ideas and in any case, the material that I get on the paper is very much adapted. Some of the activities I actually did by myself and are associated with the programme, but other times I take the ideas and adapt them depending on the class.*"

Moreover, they reused the materials found in other teachers' websites. Teachers believed they could trust such materials as they had been tested. Also, if other teachers published them, it was because the quality was good.

> Mrs. White: *"Teachers that have their own websites to upload instructional materials that they have already used and therefore the material is quite reliable. Other websites contain unreliable materials, so we have to make a careful selection."*

> Mrs. Brown: *"I usually adapt the materials I find in websites from other teachers that publish worksheets or specific schemas. As we have the IWB [interactive whiteboard] in the class, I usually look for materials that can be displayed on it. I don't use a lot of photocopies."*

Sharing materials. Whereas teachers were free to share the materials produced, when School A started the Bilingual project, its members created a physical archive (Figure 5.2) of instructional material as a response to the lack of teaching materials for teaching Italian children in foreign languages. Currently, a policy obliged teachers to organise, classify, and hand-in all the instructional materials created along the academic year in physical format, paper or cardboard, and digital format, files or pictures, when possible. In this way, they had populated a physical archive and a digital resource where instructional materials were stored and only accessible to the teachers in the Bilingual project.

> Mrs. Grey: *"Ten years ago, there was nothing to teach following the CLIL methodology. Nothing. We didn't even have English books in the school. On the one hand, there were no instructional materials. On the other hand, we couldn't fully trust what we found on the Internet. We decided to create the archive that would be useful for all the classes that were gradually being involved in the Bilingual project. Currently, the teachers who work in the classes that belong to this project, by policy, are obliged to leave the instructional material."*

> Mrs. Blue: *"The need of this archive arose because in the Bilingual project there is a high number of teachers' turnover, and considering that the project has some specificities, usually those who are new need a bit of time until they understand how to work. So having adapted material can be useful."*

Figure 5.2: The repository in School A is a physical ware drove that stores physical instructional material. It occupies one whole room.

The archive was composed of four modules. The first one contained books and films in English, Italian and German, whereas the remaining three contained the instructional materials created by teachers. To distinguish the modules, they used numbers: first, second, and third. Materials inside these three modules were organised on shelves. There was one shelf per grade, from one to five, and every shelf contained instructional materials organised in folders. Every teacher had at least three folders in the course she was responsible for. Inside the folder, there were the corresponding materials to the subjects she taught within that course, organised in individual plastic folders. For example, Mrs. Grey had one folder for Italian, one for History, and, together with her co-teaching partner, one for Maths. At the same time, her co-teaching partner had one folder for Science, English, and Art, and another folder for Physical Education, Geography, and Music. Therefore, in total, for every academic year, per class, they produced five folders on average. Once one of the modules was filled, they moved to the next one and filled it up. They managed the borrowing process with a lending book, where teachers wrote down their name, the date, and the material borrowed. However, this archive was not the solution to the problem of materials' scarcity triggered by the implementation of a multilingual approach to teaching. The archive occupied a whole room and teachers were requesting more space. Some teachers claimed that it was time to eliminate the oldest materials, whereas others refused the idea of doing so by claiming that it was part of the legacy of the school.

> Mrs. Grey: "*As long as I'm the coordinator of the Bilingual project, I don't want to clean up the archive. Why? Not because we use old materials but because they are our history. There, there are the materials created with and for the kids.*"

Mrs. Blue: "*We have the archive that we would like to withdraw, to keep only the digitized instructional materials because with the physical teaching materials we have already arrived at our limit capacity. We can't handle it anymore. Either we throw away the oldest materials or we keep it at home.*"

Materials in the folders were organised following a chronological order. Although teachers tried to safely preserve the materials by putting them inside plastic folders, often one plastic folder contained more than one paper sheet, hindering the access to the materials. Moreover, teachers from the CLIL project had not been granted access to it, therefore they needed to ask for permission whenever they wanted to access the materials stored.

Mrs. Blue: "*Only the teachers from School A have granted access to the archive. I mean, only those involved in the Bilingual project have access. However, if a colleague asks, I have no problem to lend them materials. Let's say the access is only for the teachers of the Bilingual project.*"

Mrs. Green: "*They (the instructional materials) are all kept in one of the rooms in the school where we all know we can access it, and yet as we are from different department we generally ask permission but It's just out of courtesy from our colleagues.*"

Furthermore, there was no database containing the classification of the materials, and the digitised material was stored in a portable hard-drive that the teacher who coordinated the Bilingual project kept.

Mrs. Grey: "*I keep the hard-drive in my cupboard. So, teachers know that if they write me an email or if they tell me that they need the hard-drive, I give them in hand, I never leave them unattended.*"

Materials in the hard-drive were disorganised. Among other folders, there was one folder for Italian, one for History, one for Maths and another with all the subjects taught in English. However, the subfolders of these folders were organised differently: in the Italian folder, every teacher had a folder with her name and, inside her folder, there was another folder named using the grade, the subject, and the academic year. For example, Mrs. Blue had a folder and, inside her folder, she had one folder named '1B _ita_2016-17'. In this way, materials were organised alphabetically and then by grade. In the History folder, every teacher had a folder per grade and academic year. For example, Mrs. Blue had two folders: 'Mrs.Blu_5B_2015-16' and 'Mrs.Blue_1b_2016_17'. In this way, materials were organised alphabetically by teacher's name. In the Maths folder, there was one folder

per grade, pair of teachers and academic year. For example, Mrs. Blue had a folder named '1B_Mrs.Blue_TeacherName_2016-17'. In this way, materials were organised by grade. In the English subjects folder, every teacher had a folder named with the grade, her name and the academic year. For example, '1B_TeacherName_2016-17'. Inside, every teacher had one folder per subject. In this way, materials were organised by grade. Therefore, materials in Italian and History followed alphabetical order, whereas materials in Maths and English subjects folders were organised by grade. Inside each folder, materials were organised differently according to the teacher's criteria. Moreover, folders and materials were named using Italian or English in an indiscriminate way.

Digitising practices. The new policy attempted to shift teachers' practices towards their digitisation by introducing more technology in the classes. To comply with the policy, schools supplied every class with technology, such as the interactive whiteboard (IWB) that allowed the interaction with, and projection of, digital instructional materials. However, this integration resulted in a complex process dependent on the convenience of the technology and the teachers themselves. To promote the adoption of technologies, schools offered teachers different courses to learn how to use the different digital tools and how to include them in their teaching practices. Even though teachers took these courses, they found it hard to change their habits and practices to introduce technology. Teachers had the technology in the class but they did not exploit its full potential due to the difficulties in understanding and using all its functionalities.

> Mrs. Grey: "*I use the IWB but I use it at 10% of its capacity because I have taken the courses but I can't remember. Therefore I waste my time, do you understand? In my lessons, my students give me a hand because I am incapable of using well and fully the possibilities that the IWB has. Or a website, I don't understand a word.*"

> Mrs. Blue: "*Sometimes I need to visualize texts, so I use to IWB, we work together on the activities that I project on the IWB and they do it on the exercise book, so I use it as a projector. That's how it's useful, the rest of functionalities to prepare the class in a technological way, and all the special effects, I had enough, I'm sick and tired of wasting my time . . . and then sometimes it works, sometimes it does not . . . it's problematic. I stopped using it, and my life is simpler, I don't want to have further problems.*"

However, most of the instructional material created was tangible. At work, teachers preferred to use this type of material to digital ones.

Mrs. Blue: "*Children spend a lot of time on the computer and the tablet and I really think that when they are young they don't need all these special effects. I don" care whether I seem like an old teacher. There is this teacher [anonymized name] who has worked with the Education Department in the province and he is moving forward this idea of, at least in primary school, not using the computer, the IWB and all these things. And I agree with this idea.*"

Moreover, rather than moving towards digital, to make sure that the information was not lost, some teachers copied the links to interesting videos in the word document that they stored in the physical archive.

Mrs. Pink: "*Every year we collect the material to store so that others can use it. I mean the tangible materials. So, for example, if in History I show to my students different videos on specific topics, I write on the word file the link so that others can access.*"

Interestingly, when teachers requested to borrow instructional materials from other teachers, they preferred to share the digital copy, when possible, as it was easier to exchange and modify.

Mrs. Blue: "*I not only create tangible materials, but I also have the digital copy that I prefer to share, whenever it is possible.*"

Communicating. Although teachers did not have a lot of time, they tried to communicate whenever it was possible for them.

Mrs. Red: "*We try to speak, as we used to do . . . We talk, we try to find the moments in which we can speak. We are very quick in communicating.*"

Moreover, teachers communicated through courses. They needed to update their teaching skills and learn how to teach with the CLIL methodology: teaching and preparing materials for an Italian child in English was not the same as doing it in Italian. The local government offered courses for that. More interestingly, teachers in some schools, as for instance in School A, proposed courses adapted to their reality, or asked experienced teachers in the institution to share their knowledge and experience in specific subjects with those less experienced in the CLIL methodology. However, these courses were not public and only teachers belonging to that school could attend.

Mrs. Grey: "*In the past, I organized and managed courses.*"

Mrs. Green: "*The geography course was run by one of my English colleagues who had been teaching geography for probably more than 10 years in English so she basically shared her experience and her approach with us.*"

Furthermore, meetings were not a new practice for teachers. They already had dedicated time for departmental meetings and class meetings which could be laborious and implied an important workload for them as they occupy a lot of their time. More interestingly, they had found a way to leverage them by considering meetings as their chance to approach other colleagues, ask for help, and exchange materials, mainly tangible. Meetings were a way to make available instructional materials, by communicating with each other, and identifying the most relevant.

Mrs. Pink: "*Every two months we gather as a department, that is, all the teachers of Italian language and culture in the institution meet. Sometimes it's a bit hard to exchange instructional materials because meetings have an order of the day scheduled by the director. However, we always exchange instructional materials, mainly physical material to be honest.*"

Mrs. Green: "*We have the weekly planning meeting that sometimes takes a lot of time. At the same time, it can be very valuable if you think and are able to exchange ideas and to confront or to be able to ask your colleagues how they did it, how they would do it and so on. That's definitely useful.*"

Furthermore, in the Bilingual project in School A, due to the complexity of teaching Maths to Italian children in a foreign language, teachers decided to add two more hours for planning and organising the Maths class. Currently, this practice is part of the study plan and has been adopted by all the courses in the Bilingual project.

Mrs. Blue: "*We have two hours a week dedicated to planning the Math class in English. We have two hours exclusively dedicated to that. We gather, search and collect the material.*"

Problem identification

This study was aimed at identifying the target community through understanding teachers' practices in a disruptive situation, such as the implementation of a new policy. Thanks to their reflections, it was possible to identify the target community, as primary teachers in School A, and delineate the problem informed by the identification of teachers' needs.

The new policy triggered a need for finding, creating and sharing educational material adapted to the bilingual requirements. Indeed, creating and sharing educational materials was not a new practice for teachers but it became an instrumental part of the process of adapting to the disruptive situation. More concretely, educational resources became materialised attempts to comply with the new policy. Moreover, meetings, that had always been part of teachers practice, were crucial for sharing and making visible materials used and stored that, otherwise, might have been hard to find due to the lack of organisation in the archives in School A.

However, the dichotomy between physical and digital materials was present throughout the analysis of the study. On the one hand, physical materials were important to instruct students. On the other hand, teachers preferred to share the digital copies of the physical materials as they were easier to share and modify. More concretely, digital materials made the creators accountable for those materials. Teachers addressed this tension by storing their digital materials in portable hard-drives, which could be easily shared and replicated, but also granted them control over who to share materials with and when to share them. On the one hand, this limited access hampered the use of the stored digital materials, materials that could be extensively used as they were easier to share, exchange and re-use than the tangible copies of the same materials; on the other hand, it facilitated coordination among teachers through face to face interaction, which most of the teachers considered a priority.

Furthermore, when the new policy was implemented, keeping and sharing teaching materials became a paramount practice due to the materials' scarcity. In School A, scaling up teachers' personal library to a school archive in which to keep materials exposed the community dynamics in terms of organisation of materials.

Tangible archive. The creation of an archive in School A tackled the problem of the lack of instructional materials. Moreover, it supported the integration of new teachers in the school's dynamics. Furthermore, the organisation of the archive was strongly contextualised in the specific school in which it was located. The materials were arranged according to the organisation of the institution. The tangible archive has become a huge archive full of folders, where materials were stored without a pre-established order. Moreover, every teacher had a different way of organising the materials. This made them difficult to access, and very often they were invisibilised.

Digital archive. The digital archive in School A was disorganised. Folders were arranged in different ways depending on the subject where instructional materials were organised according to teachers' own criteria. There was not a pre-established way of organising and classifying materials.

Nonetheless, other factors that emerged were such as time, the use of digital tools, and teachers' skills.

Time. Teachers did not have a lot of time. They had a very tight timetable full of teaching hours and meetings that took up much of their time. Moreover, they had to prepare reports on the progress of the class and on the topics covered with the activities they used in them.

Digital tools. The integration of new digital technologies in the class was challenging. On the one hand, it seemed that schools' will to comply with the law drove them to take hasty decisions in the adoption of technologies without considering teachers' practices, their level of expertise, or the specific needs of the class. On the other hand, in spite of the change in policy and that the functionilities of the digital tools introduced in the classes might not correspond to what teachers needed, still they made use of the basic capacities of the digital tools.

Skills. Teachers' technological skills were limited. Often they felt frustrated because they did not understand how a particular functionality worked, why the tool stopped working or why it did not work. Although they were skeptical about the use of technology in their classrooms, most of the materials created were digital and that was what they preferred to share, as they were easier to lend, modify and transport.

The issues with these archives emerged from the difficulties of finding stored materials. Teachers in School A were in need of an effective way to organise teaching materials, so that there could be a homogenous way of cataloguing them, and therefore, facilitate its access. At the same time, the organisation could help to create an index to access the materials in the tangible as well as in the digital folder. Moreover, the process of creating a classification should not imply any extra workload for them.

5.2.2 Step II: Problem refinement

The problem identified in this study was refined in two parts: through a focus group described in Part I and through a prototype evaluation described in Part II. Nonetheless, the focus of the analyses was to refine the problem through engagement elicitation. To conclude, Part III discusses the results of this step. To conduct this study, I wrote a research proposal to the school director setting out the aim of the projects, and the needs in terms of participants required for its development. Once the community has been identified, the process of engagement started.

Part I. Focus Group

An observer and I conducted a focus group to understand whether there were other problems in the digital and tangible archives that had not been understood in my previous exploration, and whether a co-designed mobile application would be a feasible solution to support teachers in the creation of a classification to organise their materials.

Participants

Two of the schools in these institutions were following this project. For clarity, I will call them School A1 and School A2. The meeting was called via email, and, in the agenda, the introduction to the study was one of the items so that all the teachers would know about our presence. The meeting took place in one of the classrooms of the school where there were 16 teachers (13 females, 3 males) from a total of 20. Moreover, the school director decided to economically incentivise those teachers who decided to participate in research projects dedicated to the digitisation and improvement of the school's archives.

Data collection and analysis

The focus group was divided into two parts. The first part included the introduction of the proposal of a co-design session to create a classification system via a mobile app. In the second part, three topics of discussion were proposed to the attendees.

- whether there were other issues in the archives that had not been identified previously

- whether co-designing a mobile application to support the classification tasks would be a suitable solution

- where to start the classification considering the amount of folders that they had in the archive.

The focus group lasted 50 minutes. The second part of the focus group was registered, transcribed, and thematically analysed to consider the factors that hinder or facilitate engagement.

Findings

During this focus group teachers were expecting me to provide a fully working digital tool which would solve all their issues with their archives. Some of them were confused when I explained that they had to create their own classification, which

meant extra work for them. While highlighting the need for digitisation, this showed that the community was used to accepting digital tools, whereas their opinions and expertise were hardly considered.

Resilience to contribute. Interestingly, one of the teachers volunteered to create such an index for all the grades for Maths. They agreed that, once she had it ready, she would share it with the rest of the teachers. Although that would be the aim of the mobile app. Teachers felt motivated by the proposal to co-design a mobile app and decided to use it to create an index for Italian and History.

Task workflow. The school policy obliged teachers to submit all the materials they used during the academic year, even those that were reused from other folders what resulted in materials' repetition. Not only that, in the digital archive the same materials were usually named in a different way. Moreover, teachers also reflected on the fact that, due to a lack of control on materials some folders have disappeared, and no one knew who took them last or where they could be.

Usability. Although teachers grouped materials chronologically in the tangible archive, they acknowledged the importance of the index and the creation of a classification criteria common for all of them that would facilitate navigation through materials.

Unexpected gains. Opportunity. Similarly to Study 1, Unexpected gains emerged as the unpredicted intrinsic benefit that a participant might obtain from *engaging in the design*. In particular, in this study it was articulated as Opportunity, referring to the nature of the study: the organisation of the archives had never been a priority because they did not have the time and knowledge to do it, although they knew they needed it to facilitate access. They took my proposal as their opportunity to solve their long-time problem. They reflected on the best way to proceed and decided i) to have two different classifications, one for the archive in School A1 and another for the archive in School A2, so that the materials would not be mixed; and ii) to start organising and classifying Maths from the current year, because they had a lot of materials and the folders lacked index and the digital ones were not organised.

Expected gains. Similarly to Study 1 Expected gains refers to the intrinsic benefit that a participant might expect to obtain after *engaging in the design* of a collaborative system. In particular, in this study it was articulated as the satisfaction of curiosity, affirmation of ego as well as from a cognitive point of view.

Curiosity. During the focus group, teachers showed their expectations by reflecting on possible functionalities they would like to see in the mobile app such as print

scanned materials, or facilitate searching. While sharing their understanding on the advantages and disadvantages that the app would bring to their practices, this highlighted their expectations.

Idealism. During the discussion, teachers reflected on the reason for the existence of the archive concluding that, in addition, to overcome the lack of materials and support on teachers' practices, the other reason was to support those teachers who were not technically competent, so it helped them to keep up with the creation of materials.

Overall, while archives were important to facilitate sharing and reuse, their organisation has never been a priority for them. Teachers engaged in the best way to start organising them starting from this academic year's Math folder. Moreover, one teacher volunteered to create the index for Maths, whereas others volunteered to co-design the mobile app to create the index for other subjects. Teachers reflected on their expectations around the mobile app and the advantages or disadvantages that it would bring. From this focus group, ten teachers (eight female, two male) decided to participate in the next step of the study. Six of them belonged to School A1 while four of them belonged to School A2.

Part II. Prototype evaluation

The prototype of the mobile app that would facilitate the organisation of materials. The evaluation was divided into two steps: A, a low-fidelity prototype evaluation and B, a high fidelity prototype evaluation.

Participants

From the focus group, ten teachers decided to participate, two male, eight female (Table 5.4). From this set, three of the participants had been involved in the exploratory study described in Section 5.2. Half of the teachers were Italian, whereas the other half came from different countries. All of them spoke Italian as well as English. Their experience in teaching in the Bilingual project varied from a few months to more than ten years. The grades ranged from first to fourth. Teacher 2 volunteered to create the index for Maths. Moreover, Teacher 11 was not present on the day of the presentation but she contacted me, first through a colleague and then via email, to let me know that she wanted to take part in the study.

A. Low-fidelity prototype evaluation

The low-fidelity prototype of the mobile application, created using Balsamiq[1], was sent via email. This option was selected to provide flexibility as it allowed teachers

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[1]https://balsamiq.com/

School	Pseudonym	Age	Teaching Experience	Teaching in Bilingual
School A1	Teacher 1	56 - 60	21 - 25	11 -15
	Teacher 2	46 - 50	16 - 20	6 -10
	Teacher 3	41 - 45	< 10	1 -5
	Teacher 4	41 - 45	16 - 20	6 - 10
	Teacher 5	31 - 35	11 - 15	1 - 5
	Teacher 6	36 - 40	11 - 15	1 - 5
School A2	Teacher 10	31 - 35	11 - 15	< 1
	Teacher 11	51 - 60	26 - 30	1 - 5
	Teacher 12	31 - 35	< 10	< 1
	Teacher 13	46 - 50	16 - 20	<1

Table 5.4: Demographic data of the participants in prototype evaluation

to access it when they had time. The prototype was in pdf format and participants could access it through an URL. There were two different prototypes:

- one to add a folder to the database available through this URL: `https://mmercedeshuertas.github.io/mercedeshuertas.github.io/Mobile_App_Add_folder.pdf`

- one to add the teaching materials to the folder previously added and available using this URL: `https://mmercedeshuertas.github.io/mercedeshuertas.github.io/Mobile_App_Add_topic.pdf`.

In both of them, the search option was available, allowing teachers to search for materials in the database by subject, grade, and academic year. The email contained further instructions on what they should do with each of the prototypes and what to select to include a folder and a material in the database. A survey was attached in the same email to be answered after the use of the prototype.

Findings

Teachers tried to access the prototype. However, it was not clear to them how they should do it. On the one hand, those who tried to open the URLs encountered some issues. For example, Teacher 4 sent me an email where she explained that the URL she was trying to access gave an error. She typed `https://mmercedeshuertas.github.io` deleting the part of the URL where the pdf file was specified. I replied to her saying that she should copy-paste the entire URL or just click on the one I provided in the email. When I encountered her I asked her whether it worked. She told me that she did not try again. On the other hand, many of them claimed that

they did not have time to access and go through it. Some of them said that they saw the email, but they ignored it. Therefore, none of them tried the online prototype.

The failed evaluation highlighted the issues and challenges the use of technology implied for them, while showing the need for a more monitored approach using a more realistic design for the prototype of the mobile app so that it would not lead to confusion.

In the next step, a one-to-one evaluation was planned, accommodating to their time constraints and technical skills, so that they could access to all the functionalities from one single prototype, and I could observe how they interacted with it.

B. High-fidelity prototype evaluation

The high-fidelity prototype of the mobile application was designed to facilitate teachers' organisation of materials inside their folders, and enable them to search in the database of included materials according to three different criteria: subject, grade, and academic year, by scanning a QR code. The codes were created by using an id for each of the folders and for each of the materials in the folders. The id was designed considering how materials were organised in the archive. For example, the id 'SchoolA1-1-1-001' corresponded to a folder located in School A1, in module 1, on shelf 1 and whose id was 001. For the teaching materials, an extra number was added to the previous id so that 'SchoolA1-1-1-001-001' corresponded to a teaching material whose id was 001 and that was located in the folder whose id was 'SchoolA1-1-1-001'.

The high-fidelity prototype was implemented using Android Studio, a platform to develop mobile applications created by Google. The database to store materials was implemented in Firebase, a Google service to create and manage databases for mobile applications. Only mobile phones with the Android operating system could install it.

Data collection and analysis

For this study, the same set of participants was involved. This time I stayed in the schools all day from 8.00 am to 5.00 pm so that, whenever they had a free period, they could come and try the prototype. For three days I was in the room where the archive was located in School A1. For two days I was in the teachers' room in School A2, as the room where the archive was located was frequently used for teaching. When teachers came into the room, I transferred the app to them through Bluetooth. Data corresponded to observations and fieldnotes during the interaction, and informal interviews with participants while they were testing the prototype (Table 5.5).

Method	Data Source
Observations and fieldnotes	7 interactions with the high-fidelity proto-type
Informal semi-structured inter-views	7 transcriptions

Table 5.5: Methods ad data collection for the high-figelity prototype

Findings

Six out of ten participants tried the prototype. Two teachers decided not to try it until the index for Maths was ready. Another one did not install it because his co-teacher did it. Another teacher was sick during the week of the testing. During the evaluation, Teacher 10 had a phone that did not support Android. However, he found another one so that he could use the prototype from his own device. Teacher 3 had a phone for which some of the functionalities did not work. She suggested using mine and hers so that she could see the prototype fully working and by adding the date to the tangible materials manually.

During the evaluation they reflected on how they usually organise their own folders. Keeping digital materials in chronological order was problematic. Only Teacher 10 kept the chronological order in the digital files, by using numbers when naming the digital files.

Missing functionalities. Teachers liked the idea of using the QR codes as it was simple and fast. However, they thought that they could get to see the materials associated with the QR codes. Some teachers classified the app as useless: they already knew that a specific material for a specific grade was in a specific folder. what they needed was to see the material itself so that they could decide whether they wanted to reuse it or not. Therefore, the more they understood the functionalities of the prototype, the more they managed to articulate what their real needs were. Reflecting on their previous experiences with technology helped them to articulate their expectations. For example, Teacher 4 mentioned that, in a previous school where she worked, they were using Google Drive and that was much more convenient to facilitate sharing practices.

By the end of the evaluation, teachers realised that the mobile app did not accommodate their practices. By questioning the utility of this mobile application it emerged that their needs were for a facility to access and visualise materials. However, the digital materials were stored either individually, on their personal devices, or commonly, on a hard-drive.

After the two attempts to evaluate a mobile app prototype to support the materials' organisation and classification tasks, it resulted in a failed proposal. The initial steps to *engagement in the design* could be observed as participants felt legitimised when they did not accept the prototype showing their engagement when reflecting on how to better organise teaching materials, and when they articulated their needs and expectation when reflecting on their previous experiences.

Part III. Discussion

This phase of the study required a focus group and a prototype evaluation to refine the identified problem, where the initial steps towards participants' *engagement in the design* could be observed.

The existence of the archives and their prolongation over the years was the result of supporting the community of teachers, especially new teachers and those less technologically competent teachers so that they could keep up with new material's creation. Teachers admitted that the organisation of materials had never been a priority because they did not have the time and knowledge to do it. Therefore, they saw my proposal as an opportunity to solve a long-standing issue by considering me as an expert in technology who would solve their problems. Curiosity drove 10 teachers to participate in the prototype evaluation. I was the facilitator to initiate the process of engagement in the design process (Vines et al., 2013). The two attempts to a mobile app prototype failed: some teachers refused to use it, some others classified it as useless. However, it helped them all to engage and articulate their needs and expectations, highlighting their determination and legitimation by not accepting any tool while showing participants' initial steps towards the appropriation of the co-design process. They freely expressed their opinions on what they thought about the prototype. Some elements that facilitated or hindered participants' engagement were already observed in these early stages of the study (Table 5.6).

Hence, the issue to address in this study was not only the creation of a common way to organise teaching materials, but also a system that would grant access to materials from any device. In this situation, and considering that teachers were enthusiastic and willing to change the organisation of the archives, I decided to conduct a second round of informal interviews to facilitate their reflection on the issues of the archives.

Barriers	Drivers	
Missing functionalities	Unexpected gains. Opportunity	
Task Workflow	Expected gains.	• Curiosity
		• Idealism
Workaround		
Resilience to contribute		

Table 5.6: Barriers, drivers, and workarounds identified in the Step II

5.2.3 Step III: Problem consolidation

Archives lacked of organisation to facilitate the materials' navigation. The evaluation of a mobile app prototype failed. Nonetheless, it helped teachers to express their needs and expectations. This step aimed to consolidate the problem by conducting another round of interviews to understand the issues and uses of the current resources, physical and digital, according to the teachers, while asking them to reflect on how to improve the existing ones.

Participants

In order to collect teacher's views about the two archives, physical and digital, an email was sent to all the teachers in the Bilingual project from both schools to let them know that I would be in the teachers' room to collect their opinions. In total, 12 teachers of the Bilingual project participated, two male and ten female. From the 12 teachers, nine of them were the same participants as in the evaluation session. Moreover, seven were from School A1 and five from School A2.

Data collection and analyses

In order to further understand the issues of the current archives, two posters were placed in the teachers' room in both schools (Figure 5.3) where each poster contained a question. On the yellow poster, the question was: "*How do you feel about the physical archive?"* with two pictures of the current physical archive. On the blue poster, the

question was: *"How do you feel about the current digital archive?"* with two pictures of the hard-drive.

Figure 5.3: On the left-hand side a picture of the poster in School A1. On the right-hand side a picture of the posters in School A2.

Sticky notes in two different colours and a pen were available close to the posters so that they could leave their comments at their convenience. In School A1 the poster stayed for 10 days. In School A2 the poster stayed for 11 days. Moreover, I informally interviewed the teachers who approached the posters. They reflected on the issues of the archives, articulated the missing functionalities and how they imagined their improvement (Table 5.7).

Method	Data Source
Informal interviews	12 transcriptions
Posters	82 comments on different sticky notes

Table 5.7: Methods ad data collection in problem consolidation phase

Findings

Acknowledging the issues of the existing archives, digital and physical, was a way to engage teachers with the classification process. Teachers reflected on the content of the archives and realised that it was not the same. For example, when they photocopied a page from a book or from someone else's folder, they did not digitise it, they only made an extra copy to put it in the physical folder.

Usability. Physical archive. With respect to the usage of the physical archive, opinions were divided among those who wanted to remove it and those who wanted to keep it. For example, one teacher left a sticky note saying "much-appreciated symbol of our 'past' hard work", as a reflection that it was time to move to a more digitised solution. Although most teachers tended to use digital files to prepare

their teaching materials, two of the interviewed teachers admitted that they mainly used the physical archive: one of them admitted that she was not technologically competent and preferred tangible materials, the other said that the physical archive was useful if one limited oneself to two folders.

Teachers reflected on the reasons to use the physical archive. Initially, teachers admitted to not using the folders. However, they reflected that sometimes they borrowed materials, and they did this for four reasons:

- to follow the same strategy as their preferred teacher

- to check what materials were used to cover the topics. For example, one teacher admitted that she had a favourite teacher, so she tended to borrow her folder from the archive to look at the materials included and how they were organised

- to consult the chronology followed. However not all teachers numbered the pages or wrote the date on the materials. For example, a teacher showed me her folder where the pages lacked any page number or date. Only one of the teachers wrote the date she used the materials on the reverse of the page, but she admitted that sometimes she forgets to write it

- to reuse specific materials that did not need to be modified. For example, Teacher E said that she needed a model of the respiratory system for her science class. She took one folder where she knew there was a model she liked and did not need modification. She photocopied it and returned it to the folder.

At the same time, they reflected on the difficulty of reusing the materials in the tangible archive. Materials were designed to be used in a specific context or the class where they were implemented. For example, one of the teachers said that Maths problems depended on the class where they were applied. Moreover, materials were left without instructions, making their reuse difficult. Nonetheless, one of the English teachers said that subjects that were taught in English were more organised than those taught in Italian. Furthermore, materials could not be exchanged between schools. A teacher from School A2 mentioned that she went to School A1 to borrow some materials and she had to photocopy those that she needed because she was not allowed to take the folder out of School A1.

While showing their reluctance to admit that they use the tangible materials, these testimonials highlight teachers' dependency on tangible materials, probably due to gaps in the digital archive.

Usability. Digital archive. Teachers reflected on how they used it: In the beginning of the academic curse, they asked the coordinator for the hard-drive. Then, they copied all the materials they thought they would need during the year. If, during the academic year, they need more materials, they had to send an email to the coordinator to request them and wait for the email with the information requested.

While showing the convenience of using digitised artefacts, as they were easy to share, this highlighted the impediments to sharing them within the current digital archive.

Moreover, the lack of standardisation to organise materials in the digital archive made the practice of searching difficult. Finding materials in the archive took a lot of time, as they had to go through many unclassified and similar files. For example, one teacher left a sticky note saying 'A BLACK hole sucking away time and energy'. Another teacher said that she could not find materials in the digital archive because she could not understand how others organised the materials. Materials' repetition was observed here as well. While showing that the existing archive was an elongation of individual archives, it highlighted the need for a common way to organise and classify materials.

Surprisingly, although chronology was important for teachers it was difficult to articulate for many of them. Some checked the modification date of the file, whereas others checked the bimonthly reports, a report they had to submit every two months with the topics covered and the activities followed, or the 10-month plan, that guides teachers' activities in the academic year. While showing the importance of chronology, these three approaches showed the different strategies they adopted to understand the materials' order.

Missing functionalities. Using their previous experience with other systems as reference, teachers reflected on how their practices would differ if they could have access to their materials from anywhere at any time.

One of the teachers reflected on her folder in Google Drive and how things would be organised if they could use a shared Google Drive folder. She concluded that it would be an optimal solution if all teachers could store and access their materials from anywhere. Another teacher wanted to add a description to the files to describe how a material was used, and tags, to notice that one file can be used in several topics. A teacher reflected on Google Classroom and admitted that only teachers should access the resource. Another teacher was concerned with naming files and folders as giving too generic names could result in many files or folders with the same name across grades.

While reflecting on similar tools would facilitate envisioning their future practices, teachers showed their engagement when proposing how to better organise materials.

Unexpected gains. Opportunity. This intervention gave the opportunity to teachers to approach me and talk to me in informal way. Many ignored me, but those who talked to me expressed what the archives meant for them in terms of work as well as in terms of feelings, as accessing them was frustrating at times.

Discussion

After the teachers' rejection of the mobile app and considering that teachers were enthusiastic and willing to help, I decided to further explore the issues around the archives. Teachers engaged in interesting conversations where they reflected on the issues of both archives, highlighting factors that facilitated or hindered their engagement with the current archives.

With respect to the physical archive, some were clear that they should stop contributing to it, whereas some others still use it. However, there were several reasons to use the folders in the tangible archive, for example, to follow the chronology or reuse a specific material that did not need modification. Finally, materials' specificity and lack of instructions hindered their reuse and could not be exchanged between schools.

With respect to the digital archive, accessing the materials stored in it depended on the teacher who kept it. Moreover, the lack of standardisation hindered finding materials across folders. Another important aspect was understanding the chronology of materials, which was an important need for them, but hard to achieve. By reflecting on other tools or similar experiences supported their envisioning of similar resources that would better support their practices.

In this round of informal interviews, participants freely expressed themselves when they admitted that it was time to move to a more digital solution. They suggested functionalities they would like to have in a future digital resource by reflecting on previous experiences and their own knowledge, showing their appropriation of the design space. In the end, they felt legitimised to express their opinions: these were their practices and they were their archives. The set of factors to hinder or facilitate engagement identified in this phase are presented in Table 5.8.

Barriers	Drivers
Usability. Physical archive	Unexpected gains. Opportunity
Usability. Digital archive	
Missing functionalities	

Table 5.8: Barriers, drivers, and workarounds identified in the first stage

This final step allowed the final identification and definition of the problem that this study was tackling. Overall, what emerged from this intervention was that most teachers preferred a digital resource to facilitate their creating, reusing and sharing practices, as well as finding and exchanging materials. Moreover, materials should be organised following a common classification criteria and a chronology.

5.3 Perceiving problem and conceiving solution

This phase was informed by participants' articulation of needs, mainly improvement of accessibility of materials and their organisation. The same set of participants was contacted to co-design a repository. After the co-design sessions, and with the data collected, their proposals were transferred to a real online repository. The focus of my analyses was to investigate *engaged in the design* while teachers are involved in the co-design activities.

5.3.1 Participants

For this phase, seven out of then teachers were available to participate (two male - five female) (Table 5.9). The other three, although they were contacted several times to try to organise the session, were busy and it was difficult for them to participate. Among the participants, there were three pairs of co-teachers. Moreover, three were teaching subjects in Italian, whereas the other four were teaching subjects in English. They were teaching first, second and fourth grades.

5.3.2 Data collection and analyses

For the co-design session, I took into consideration the teachers' time constraints, as observed in section 5.2 and the difficulty of gathering all of them at the same time in the same room. Therefore, I had to adopt a flexible approach (Kraff, 2018); I conducted the same workshop three times, so that all of them could participate. In the first workshop, Group 1 was composed of Teacher 6 and Teacher 7, who

School	Pseudonym	Grade	Subject
School A1	Teacher 1	2 Grade	Italian subjects + Math
	Teacher 2	2 Grade	English subjects + Math
	Teacher 3	4 Grade	English subjects + Math
School A2	Teacher 4	2 Grade	Italian subjects + Math
	Teacher 5	2 Grade	English subjects + Math
	Teacher 6	1 Grade	English subjects + Math
	Teacher 7	1 Grade	Italian subjects + Math

Table 5.9: Demographic data of the participants in co-design session

were co-teachers, and this was their first year in the Bilingual project. In the second workshop, Group 2 was composed of Teacher 1, Teacher 2, and Teacher 3, who had different years of experience in the Bilingual project. Finally, Group 3 was composed of Teacher 4 and Teacher 5, who were also co-teachers with less than two years experience in the Bilingual project.

Workshops lasted from one and a half to two hours. To guide participants through the co-design session, seven activities were proposed using the "*How might we . . . ?*" approach from Design Thinking. The seven activities emerged from the reflections in the previous phase and the observations from the hard-drive. The aim was to facilitate reflection on their practices as well as to facilitate mutual learning about each other's practices.

- Activity 1 - How might we name folders/files? - To decide the language to be used when naming files and folders.

- Activity 2 - How might we group the materials? - To decide the organisation of the folders.

- Activity 3 - How might we organise the materials? - To design the organisation of the folders on paper.

- Activity 4 - What might we include in the folders? - To decide what type of information should be included in the folders.

- Activity 5 - How might we keep the chronological order? - To find a way to maintain the chronological order of the files.

- Activity 6 - How might we avoid repetition? - To discuss a way to avoid the repetition of files.

- Activity 7 - How might we organise materials by topics? - To discuss about a common way to organise the materials.

To facilitate reflection, printed screenshots of how the existing digital archive was organised were provided. All the sessions were audio-recorded and the paper sketches analysed.

5.3.3 Findings

Participants engaged in the activities suggested reflecting on how they were organising their own materials as well as how the existing archives were organised. Interestingly, although in separate groups, teachers agreed on organisational aspects, such as naming files and folders according to the language used to teach them, reflecting their common understanding of the issues. The designs resulting from the three co-design workshops are presented in Table 5.10 and Table 5.11.

Usability. During the co-design session, teachers reflected on ways to organise materials chronologically and proposed several options to facilitate chronological organisation. Group 1 thought about adding the date of the day in which a file was used to the file name, but then they realised it would be too complicated, so they discarded the idea, Group 2 suggested using the bi-monthly report, and Group 3 suggested adding a digit to the name of the file, that would indicate the order in which files were used. Interestingly, it emerged that, when teachers wanted to find materials, they did not use the search box provided by the file system. Instead, they searched folder by folder. While showing that teachers would use the online repository as they would use the physical folder, it highlighted their lack of expertise in technology.

Task workflow. Teachers proposed that, to avoid repetition, the reused materials should not be stored more than once. Furthermore, two groups suggested measures to cope with this issue; Group 2 suggested submitting only those materials that were modified and Group 3 suggested acknowledging the original author in the bi-monthly report by referencing the teacher whose materials were reused. They were concerned that this would imply changes in the current policies that obliged them to submit all the materials used in the academic year. For example, Group 2 feared that the people in power positions might not agree with it as these participants considered that the bi-monthly reports and the policy of submitting all materials at the end of the academic year were a way to control teachers as well as the work they do along the academic year. While they were willing to change the way materials were submitted, these testimonials highlighted their concerns their suggestions would imply on the community.
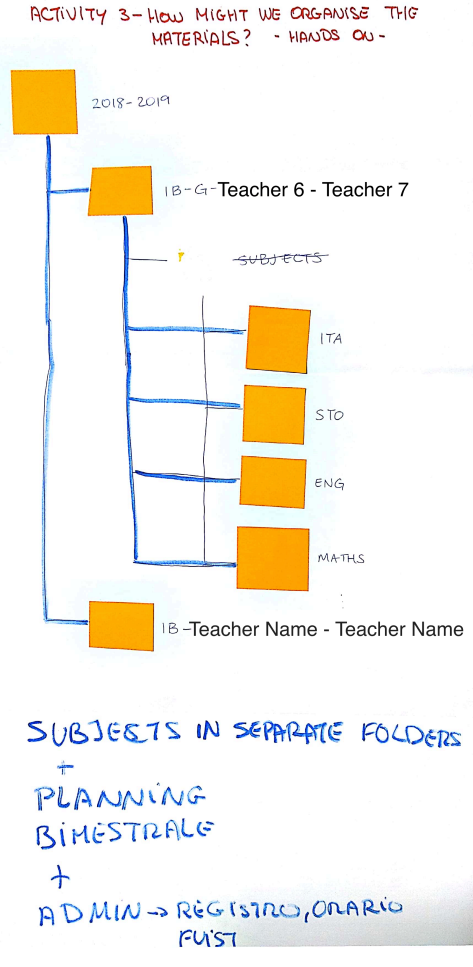
Design	Description
ACTIVITY 3 - HOW MIGHT WE ORGANISE THE MATERIALS? - HANDS ON - 2018-2019 1B-G-Teacher 6 - Teacher 7 SUBJECTS ITA STO ENG MATHS 1B -Teacher Name - Teacher Name SUBJECTS IN SEPARATE FOLDERS + PLANNING BIMESTRALE + ADMIN → REGISTRO, ORARIO FUST	Group 1 - Organised by academic year. In this design, materials were organised by academic year. They justified this choice by saying that for them, it was easier to look for the materials that have been used by the teacher the previous year. Inside the academic year folder, every pair of teachers of the different grades would share a folder with the corresponding subjects. This sub-folder would be organised by grade. They would also include two separate folders one for the bi-monthly reports and another folder to keep the timetable and the list of students. Their idea emerged from the facilitation of finding quickly what the previous year teacher did, in terms of teaching materials, topics covered, and chronology followed. With their proposal, all materials from a specific academic year would be together, and not spread across folders as in the existing digital archive. While showing that teachers replicated their current practices this design highlighted that teachers' practices are hard to change.

Table 5.10: Design by Group 1

Unexpected gains. Opportunity.
Appropriation. At the end of the workshop, considering that participants were willing to contribute to the project even out of the design space, we decided to continue with the organisation and classification of other subjects. While it allowed participants to think about the best way to organise their materials out of the design space, reflecting their ideas on a doc file that would be shared among them later, it would engage them with the organisation and classification out of the design space. They agreed that English teachers would create the index for English and Geography, and Italian teachers would create the index for Italian and History. Teachers with same grade and subjects shared the responsibility.

Legitimation. While teachers could reflect and leave their opinions on what they expected from an online repository by designing it on paper, the different activities offered them the opportunity to reflect on current issues and express how they would solve them, according to their understanding.

Freedom, For all of them, being involved in the co-design activity, having the opportunity to express their opinions about organisation and being listened to, was a new experience. During the co-design activities, they realised that they had the knowledge and the possibility to change the way materials were organised in the archives to facilitate their practices. In pairs, or in small groups, they discussed their practices and reflected on them to come up with a good design that would support their practices.

Expected gains.

Learning. The designs were the result of mutual learning on how each individual organises materials, how they understand the current digital archive, and how an online repository would facilitate their practices. Teachers inspired one another and contributed with their perspectives on the design. The designs are the result of accomplishing the need to find materials according to the way they understand their practices and emerged from common agreement between the participants in the groups and reached after sharing and learning their different views and ways of thinking.

Idealism. Teachers took this workshop as an opportunity to learn from each other as well as an opportunity to improve their own practices together with the community's practices.

Design	Description
	Group 2 - Organised by grade. In this design, materials should be organised by grade, where all subjects should be in separate sub-folders. Teachers included the grade in the name of the folder to distinguish them. Moreover, they added an extra folder to keep the year plan and the bi-monthly reports. In this design, teachers reflected on the way they would like to see the archive: as a library in which to find materials organised by grade and topic. While showing a will to improve the archives and their practices, this design highlights a further understanding of the problems in the current organisation of the archives.
	Group 3 - Organised by grade and by subject. In this design, materials would be organised by grade and by subject so that teachers can look for materials using two different strategies. For materials organised by grade, every pair of teachers would have a folder per academic year. Inside, there would be a sub-folder with all subjects taught in Italian, another for all the subjects taught in English, and a separate one for Maths. An extra folder would keep the year plan and the bi-monthly reports. For materials organised by subject, there would be a folder per subject where materials will be organised by topic and grade. Teachers would search by browsing folders. While this showed their current search practices, it highlighted the lack of understanding of how technology could facilitate finding materials.

Table 5.11: Designs by Group 2 and Group 3

5.3.4 Discussion

The following table, Table 5.12, summarises the factors that hindered and facilitated *engagement in the design* identified in the co-design session.

Barriers	Drivers	
Task Workflow	Unexpected gains. Opportunity	• Appropriation • Legitimation • Freedom
Usability	Expected gains.	• Learning • Idealism

Table 5.12: Barriers, drivers, and workarounds identified in the second stage

Overall, while the co-design session reflected teachers' current practices, and how they rely on them, it also showed a lack of understanding of how an online repository could change their practices. Teachers' designs were the result of learning different organisation strategies and shared views with the aim to improve their practices as well as their community. Moreover, teachers agreed on different topics even though they were in different groups, showing their common understanding of the issues. Avoiding repetition was a controversial issue and they knew that their suggestion would go against the current policy. Furthermore, they showed their appropriation and engagement of the design when they took it beyond the design space by deciding to organise and create the classification of other subjects in their spare time. Through out the co-design process they freely express their views and concerns showing their legitimation to propose the design of a repository according to their views.

5.3.5 Prototyping

Considering that teachers were already familiar with Gmail, their limited tech-skills, and that adding another tool to be learnt would create an extra burden for them, I selected Google Drive as the platform to turn the co-designed prototypes into a real online repository. This decision was informed by the fact that teachers in the study had a Gmail account, with their personal and/or institutional account; some of them were already familiar with Google Drive. Moreover, Google Drive was easy to access from anywhere, at any time, using different devices, and it allowed file

sharing. Furthermore, Google Drive includes applications similar to those included in the Office package, such as Word and PowerPoint which, as observed in section 5.2, are the ones preferred by teachers. Furthermore, Google Drive has offline capabilities, so that they could access materials even if they did not have Internet connection. It also saves changes in the documents automatically. Finally, it allows adding descriptions to the files and downloading them in different formats. To implement the prototype, I created a Gmail account. In the associated Google Drive, three different folders were created, named Option 1, Option 2, and Option 3 (Figure 5.4). Each of these folders contained the design of one of the groups; Option 1 corresponded to the design of Group 1; Option 2 corresponded to the design of Group 2; and Option 3 corresponded to the design of Group 3. Inside every folder, teachers could see the replication of their co-designed repository proposed by each group of teachers in the co-design phase.
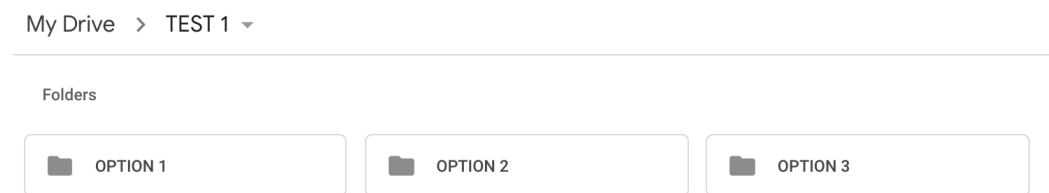
Figure 5.4: Prototype implemented in Google Drive

5.4 Trying out and evaluating the solution

The aim of the prototype evaluation was to make teachers reflect on the feasibility of adopting their design and how their practices would change. To this end, the same set of participants was involved. From the co-design session, a set of designs emerged as a result of sharing each others views in common. Considering that all of them were familiar with Gmail and some of them were Google Drive users, Google Drive was selected to implement the prototype as it is a less intrusive tool in teachers' practices.

The evaluation process was flexible and conducted separately with each of the three groups, according to their availability. The aim of my analyses was to validate the set of barriers, drivers, and workarounds.

5.4.1 Data collection and analysis

The evaluation session was conducted three times, once per group. Every session lasted from 30 to 45 minutes. During the sessions, every teacher was using a different computer and evaluating the prototypes individually. Participants were

asked to complete the same task in their corresponding designs. Teachers of the Italian subjects were requested to upload a file in the folder for the Italian subject, teachers of the English subjects were asked to upload a file in the folder for the English subject. All of them were asked to submit a bi-monthly report.

After using the prototype, a group discussion was held where they reflected on each of the prototypes proposed guided by the following questions:

- What do you think about your design?

- Would you improve it?

  - If yes, how?

  - If not, why?

- What do you think about the other designs? How easy is it for you to access the materials in your design?

- How easy is your design compared to the other designs?

Moreover, to facilitate discussion and reflection, the original designs on paper were provided to facilitate the visualisation of each of the three designs.

The data collected (Table 5.13) corresponded to audio-registration of the interaction, audio registration of the focus group, and paper sketches. This data set was analysed following a reflexive orientation to understand factors that would hinder or facilitate engagement.

Method	Data Source
Audio-registration evaluation	3 audio-registrations
Focus group	3 audio-registrations
Paper sketches and notes	3 paper sketches

Table 5.13: Methods and data source for the evaluation of the online repository

5.4.2 Findings

Four teachers, out of seven, completed their indices for the grade and the two subjects they agreed to create. Teachers were excited to see how a paper prototype could be converted into a real online repository. During the evaluation session,

teachers engaged in the analysis of their own designs as well as in that of their colleagues, reflecting on the reasons that drove them to design the repository in that way, and what were the advantages and disadvantages of the designs proposed.

Task workflow. While avoiding repetition was an important issue highlighted in previous phases, teachers in Group 3 found an advantage in repeating materials who suggested to upload materials twice to facilitate finding materials by grade and by subject. I called this **resilience to change**.

> Teacher 5: "*It is repeating, but if it would give us English teachers work in a cross curricular way at the fingertips if you need it.*"

Moreover, while this reflected the way they organised their physical materials, it also highlights the lack of understanding of how to search materials in an online repositories.

Another example of the resilience to change emerged when teachers reflected on their work practices. Teachers rely on the previous year's teacher or on a specific teacher to check the materials used and the chronology, as shown in the section 5.2. Nonetheless, Group 2 teachers reflected that, on a system like theirs, it would be hard to recognise the author of materials as they would not be organised by teachers' names.

> Teacher 3: "*If somebody wants your materials, and they access to our design they won't know which ones are yours.*"

Instead, according to Group 3, having the name of the teachers in the folders would optimise materials' search.

> Teacher 5: "*If I know I click on what Teacher 3 has done I know I only have Teacher 3's materials. And if I don't like it, I go somewhere else. If somebody does not work similarly as me they would never probably click on mine because they would choose someone else.*"

While showing the importance of moving forward in the organisation of materials, these testimonials highlighted that they rely on their long-term practices, such as reusing a specific teacher's work and searching materials as they would do in a physical folder.

Usability. Throughout the project, chronology was an important factor for teachers. Teachers in Group 2 realised that, in their proposal, the chronology would be lost just as in the current digital archive.

> Teacher 2: *"In a [physical] folder you have your structure, but here [in their prototype] everything will be mixed. I never used the digital, because in the physical folder you can look the time sequence at what she [the previous teacher] did, but if you are saving everything you don't see the order. But it's always like this in the digital archive."*

While highlighting the importance of chronology, it showed that it is very difficult for them to come up with a solution probably due to their dependency on physical folders.

Interestingly teachers talked about the problems that emerged when digital materials were used with different applications, such as Pages, Microsoft Office or Open Office, and how some teachers did not understand that different platforms codified fonts and shapes differently, resulting in a loss of the materials' format. However, they were constrained not to use files in pdf.

> Teacher 2: *"The problem is that, if you copy the same file in 20 different computers with different systems. I work in pages and she [teacher's name] works in Word. Tables and images go away."*

While showing that digitising practices was an important aspect for teachers' practices, it highlighted that the more basic aspects of digitising could represent problematic issues to teachers, such as understanding font codification in different platforms.

Moreover, during the evaluation, teachers tried to become familiarised with the system, as most of them had not used Google Drive. Teacher 6 was familiar with Google Drive and added the files in a very agile manner without assistance. However, others needed instructions on how to upload files to the repository.

> Teacher 3: *"As you work, you can upload at the end of the year, or you do it throughout the year. If everyone is more systematic, as you produce material you upload it, and then it's down to the earth."*

While the online repository was new for many of them, the evaluation highlighted their interest in its functionalities and how their practices would have to be adapted if a online repository were to be adopted.

Missing functionalities. Teachers in Group 2 reflected on the fact of materials' obsolescence. They were aware that some materials, after some time, were outdated and hard to reuse. They proposed two ways to control the less frequently used files, one of these ways would be by using a flag for the files.

> Teacher 2: *"Is it possible to have that kind of flagging system. You know you do like Wikipedia system, if you find something that it's no longer useful, instead of deleting it yourself, you could flag it."*

Teacher 2 proposed that if someone was using a flagged file, she could remove it, whereas if someone placed a flag and no one removed it, at the end of the academic year this file could be removed. Moreover, Teacher 3 suggested the use of a rating system so that files could be evaluated according to their usefulness. Those with a higher number of stars would be ranked higher in the list.

> Teacher 3: *"If there are things that are worth to use, with the star you flag it quantitatively, and those are the things that are going to show up first . In this way you could retrieve the files that are the most used."*

While teachers reuse teaching materials, this highlights that they were aware of the fact that, after some time, some materials are obsolete and should be removed.

Expected gains.
Learning. During the evaluation of their own designs, participants revised and adapted them, learning from the ideas proposed by others. For example, teachers in Group 1 and Group 2 learnt from Group 3 that their prototype could be more organised by clustering materials in folders according to the language used to teach them.

Moreover members of Group 1 observed that their way of organising materials differed from the others groups' designs. They thought that the reason would be that they had not considered some more complex aspect of the archive.

> Teacher 7: *"It makes me think that the others have found the strengths of the other types of organization that maybe we have missed. I wanted to understand if the kind of organization they proposed considered other aspects that we had not considered."*

While acknowledging their simplification of the complex issue, this highlighted that, probably, their will to learn and understand the other's designs drove them to reflect further for the reasons of such circumstance.

Unexpected gains. Opportunity.
Freedom. During the evaluation session, teachers were free to express their opinions on their designs as well as on the other teachers' designs. They discussed with their design partner the reasons for some changes or for different designs. Moreover, seeing the implementations of their designs on a real online repository encouraged

them even more to revise their proposal and suggest changes or improvements in their own prototypes.

5.4.3 Discussion

During the evaluation of the prototypes, factors that hindered or facilitated engagement were observed (Table 5.14).

Participants had different levels of understanding of the issues around the digital archive. However, far from demotivating them, it encouraged them to try to understand what they did not understand, what they can learn about those better designed prototypes or what is the reason behind such different designs. Although they were aware of the difficulties of finding materials in the current digital archive, they proposed different solutions that, in the end, would avoid changing their practices, as somehow they find them efficient. This would hinder their adaptation to future proposals that might be more effective. Nonetheless, they proposed functionalities related to their understanding of the archives and the materials stored in them, considering that they can become obsolete. Interestingly, the most simple characteristics, such as file compatibility among platforms, already presents a burden for many teachers.

Barriers	Drivers	
Usability	Unexpected gains. Opportunity	• Freedom
Missing functionalities		
Task workflow	Expected gains	• Learning
Workaround		
Resilience to change		

Table 5.14: Barriers, drivers, and workarounds identified in the thrid stage

5.5 Validating barriers, drivers, and workarounds

This study aimed to validate a set of barriers, drivers, and workarounds to engagement in the co-design of a repository to store teaching resources by reflexively analysing data collected in this study through a variety of methods in the different phases (Table 5.15).

Phase	Focus	Participants
Exploring and defining the problem	To identify the community and the problem. Barriers, drivers, and workarounds emerge from the elicitation of engagement	between 16 and 7 participants
Perceiving the problem and conceiving solution	Barriers, drivers, and workarounds emerge as a result of the engagement in the co-design session	7 participants
Trying out and evaluating solutions	To validate the set of barriers, drivers, and workarounds	7 participants

Table 5.15: Focus of the analyses in the different stages of the research

The study started by exploring the design space. A series of interviews were conducted to understand teachers' creation, reuse, and sharing practices. From this exploration, the target community emerged as the teachers of a primary school who had created a physical and a digital archive to overcome the lack of materials for teaching Italian children in foreign languages, brought about by a change in the educational policy. However, these archives were not the solution to the materials' scarcity issue, as they occupied a lot of space and accessibility was a major issue. In the first steps towards participants' *engagement in the design*, a focus group allowed me to join the community by introducing a proposal to classify materials through a mobile app. Next, a prototype evaluation was conducted resulting in a failure to adopt the technology proposed because it was not fulfilling their needs. At this point, I could have stopped my research. However, I decided to continue and help teachers in the organisation of materials. Another round of informal interviews was conducted to enable teachers to reflect on the issues of both archives. From these interviews it emerged that teachers needed to access their materials from anywhere at any time. Following that, a co-design session was conducted with a group of teachers where they designed a repository to organise and classify their materials while making them available. Finally, teachers evaluated the different designs proposed. In the different steps of the study, some barriers appeared and some others did not. I will now analyse the result of this study in terms of barriers, drivers, and workarounds (Table 5.16).

5.5.1 Barriers

Task workflow. The lack of organisation and the repetition of materials were the two main issues that were perpetuated year after year, due to the policy that

obliged teachers to submit all the materials they reused and created. However, avoiding repetition was a controversial issue as their suggestion would go against the current policy. Moreover, it was difficult for them to envision how the introduction of a repository would change the way they develop some of their practices. They kept relying on their old practices, proposing similar solutions to preserve their inefficient practices.

Usability. When they installed the prototype on their mobile phones, and after using it, they classified it as useless because it was not fulfilling their expectations. Nonetheless it helped them all to articulate their needs and expectations. With respect to the tangible archive, although teachers reflected on the difficulties of navigating through materials, they acknowledged that they still used it to support their organisational practices. With respect to the digital archive, its accessibility depended very much on the availability of the teacher who kept it. Moreover, it was difficult for them to understand the chronology in the digital archive, whereas in the physical archive they trusted that the order in which materials were placed in the folders was the initial way in which they were used. Furthermore, the design of the repository was a reflection of their practices when using the physical archive. Finally, digitising their practices could be a challenging task. Basic notions, such as incompatibility of platforms, were already challenging for some teachers.

Missing functionalities. Soon after the prototype evaluation, one of the main features that participants requested was the possibility of browsing the materials. Moreover, teachers acknowledged that, after some time, materials become obsolete, so they proposed several alternatives to control those materials that were more popular and those materials that were not used.

In this study, the theme **System stability** refers to the existing teaching resources, one physical and one digital, where teachers store their materials year after year as mandated in a school policy. Teachers could not agree on whether to keep both or move to a full digital solution. They were relying on the tangible archive to facilitate some of their practices, hindering the improvement of some of their practices and, therefore, a move to a more digital solution. The existing digital archive had a very important accessibility problem: it was stored in a teacher's cupboard, hindering its extensive use. Hence, a change in their mentality was required if an online repository was to be adopted. Moreover, to facilitate the full integration of an online repository, some policies in the institution should be updated. Furthermore, power relations play an important role in the institution and teachers feared that their efforts would serve for nothing.

5.5.2 Drivers

Unexpected gains. Opportunity. Similarly to the previous study, this study emerged from the opportunistic dimension of the research. This theme refers to the lack of initial interest from the teachers' side that was transformed into true interest as teachers realised my research would be beneficial for them (Østergaard et al., 2018). The organisation of materials was not urgent for them, although they knew it was needed in order to facilitate their practices. My research helped them to talk freely, reflect and share their priorities as well as the issues that they observed when they contributed or retrieved teaching materials from the existing archives (Vines et al., 2013). Moreover, it highlighted teacher's "invisible" classification practices: teachers organised their materials in their own ways but they needed a common way to organise shared materials, facilitating sharing and searching teaching materials across courses and teachers, while learning to find common strategies to avoid issues around materials' organisation.

From the opportunistic factor, three dimensions emerged: appropriation, legitimation, and freedom to express their views.

- **Appropriation.** The appropriation started when they suggested where to start, selecting a pilot subject to create an initial classification. Furthermore, participants volunteered to create a parallel classification of other subjects, harnessing the opportunity to standardise practices. During the evaluation of the mobile app prototype, participants realised that it did not cover their needs and expectations. They fully appropriated the design space when they rejected my design proposal and, instead, articulated what they expected and needed.

- **Legitimation.** This driver refers to the ways teachers made their opinions prevail. They felt legitimised to articulate their expectations, questioning the usefulness of the application, and deciding whether to use it. The new research direction motivated them to take part in the co-design activities that led to the design of a repository. They were legitimised when proposing alternatives to solve existing issues or suggest different ones to overcome those issues that could emerge if their design were to be adopted.

- **Freedom.** This driver refers to the space created that allowed teachers to express their views on the existing archives, on the existing practices as well as on each other's designs (Østergaard et al., 2018). The flexible methodology allowed all participants to participate in their own spaces and times, so that all had the opportunity to express their views. During the focus group, there was room to express opinions and views. We, the participants and I, allowed

the evaluation of the prototype to be our means for communication and the starting point of our relationship so that it could be a driver for engagement, as described (Light, 2010). Interestingly, it helped them to articulate their needs and what they expected. On the one hand, conducting workshops and evaluations in groups favoured the freedom of expression, which otherwise might have been constrained between those who are more experienced and those who are new to the Bilingual project. On the other hand, the impossibility of having all the teachers in the same room together during a workshop made the possibility of finding an agreement and a strong proposal to which all the participants could agree and subscribe more difficult.

Expected gains. Refers to what participants gained from participating in the research. This theme is composed of three subthemes:

- **Curiosity.** This driver refers to the enthusiasm with which participants embraced the research as an opportunity to improve their practices (Reiss, 2004). Teachers showed their interest in the project and will to participate, finding their own ways to evaluate the mobile app prototype, either with a different phone from theirs or by using a combination of two. For those who were not in the first meeting who wanted to participate, they found a way to contact me and let me know their desire to participate in the study. Curiosity was the starting point of the engagement process.

- **Idealism.** This driver refers to teachers' desire to be of help to their community (Reiss, 2004). They had a strong impetus to change the organisation of their materials to facilitate access to a rich archive of teaching materials that was hard to navigate and retrieve.

- **Learning.** This driver refers to participants' learning in the design space. When co-designing, teachers discussed better ways to classify and how, in their digital archives, they were organising the materials. They discussed their practices and reasoned about why they preferred one method of organisation over another. They all appreciated each other's opinions and listened to their design partners agreeing on common ways to design a valid classification for everyone. They harnessed the space provided to freely propose and explain how they would organise materials in a repository, as well as to reflect on where the existing issues may be rooted. Each group of teachers proposed different designs on the best possible way to design a repository that would fit their needs and the way they understood their own practices.
I also learnt that teachers had a very particular way of organising and accessing their teaching materials, I had not expected to find this.

5.5.3 Workarounds

Resilience to change. Participants showed their creativity when finding different ways to keep relying on their well-established practices by designing systems that would preserve them while obstructing the adoption of new solutions.

Resilience to contribute. Participants found their alternative ways to contribute by proposing other ways to organise and create a classification of the materials.

Barriers	Drivers	
System stability	Unexpected gains. Opportunity	• Appropriation
Missing functionalities		• Legitimation
		• Freedom
Usability	Expected gains.	• Curiosity
Task Workflow		• Learning
		• Idealism
Workaround		
Resilience to contribute		
Resilience to change		

Table 5.16: Barriers, drivers, and workarounds consolidated in this study

5.5.4 Reflecting on the design space

The activities that composed the first workshop considered the requirements identified in the various steps of the study.

The power relations observed during the study threatened the acceptance of the reorganisation of materials, as well as the relationship between teachers and the the people in power positions in the institution. Talking about modifying or removing the physical archives was a sensitive matter as some teachers believed they were part of the history of the school. Nonetheless, people in power positions in the institution were willing to adopt changes and happy to have materials organised although teachers' technical skills were limited. However, it was hard to make them understand why the research proposal changed from a mobile app to the co-design of a repository. It was hard to make them understand that sometimes, in research,

researchers need to redirect their steps to better accommodate participants' needs and expectations. Although I informed them of the status of the research and tried to explain why the research changed, the people in the institution told me that I went beyond what I initially proposed. Moreover, they added that teachers were paid for a specific task and not for what they ended up doing: co-designing a repository and an alternative organisation and classification system for other subjects apart from Maths. Therefore, I was asked to stop going in that direction and redirect my steps to continue creating a repositoy just for Maths, where the classification of materials was developed by a teacher and its population would be carried out by three teachers who would be adequately incentivised.

Discussion

6

The work presented in this thesis investigated engagement considering two concepts of engagement: *engagement in the design*, the commitment people feel when taking part in a design project and *engagement in use*, the motivation which drives the users in the interaction with a system. The work was motivated by an interest in investigating *how can reflexivity help designers to investigate participant's engagement in the co-design of collaborative systems?* from a retrospective analyses based on reflexivity. To this end, the thesis follows a qualitative research approach inspired by co-design, UX, and motivation. The retrospective analysis of the data follows three phases: i) exploring and defining the problem, ii) perceiving the problem and conceiving the solution, and iii) trying out and evaluating solutions. This piece of work contributes to the body of empirical research on co-design, UX, and motivation, and, more specifically, assists researchers, designers, and practitioners who want to provide a reflexive orientation to investigate engagement in co-design.

Grounded in the literature on human computation (Quinn and Bederson, 2011) and co-design (Sanders and Stappers, 2008) as approaches to investigate partici-pants' engagement to contribute in the collaborative creation of digital resources, this research argues for the combination of different approaches to investigate en-gagement in the co-design process, such as UX (O'Brien and Toms (2008)) (Doherty and Doherty (2018)), and volunteer motivation (Ryan and Deci, 2000a) (Nov et al., 2013) (Rotman et al., 2012) (Reiss, 2004). Moreover, this thesis has adopted a reflexive orientation to investigate participants' relationships, personal expectations, commitments, and feelings along the design process (Karasti and Blomberg (2012)) (Pihkala and Karasti, 2013).

To contextualise the research, two case studies were investigated and analysed retrospectively. In both cases, participation led to engagement and therefore con-tribution to the co-creation of the corresponding digital resources: in Study 1, the creation of a linguistic resource and Study 2, the creation of an online repository to store and share educational material. However, because participation happened at different points in the design process, it was different in terms of the form. On the one hand, participants in Study 1 participated in a witting modality (Vines et al., 2013) in punctual evaluations of the UI as informants (Iivari and Iivari, 2011) by providing feedback on interaction while contributing to the resource. On the other

hand, in Study 2 participation form changed as the design process evolved. Initially, participants were involved in a witting modality (Vines et al., 2013), as informants (Iivari and Iivari, 2011) to provide feedback on a mobile app prototype. However, the adoption of the prototype was rejected so their participation modality changed to a spectator-like modality (Vines et al., 2013) by co-designing the repository in a more 'hand-on' role (Iivari and Iivari, 2011). From these retrospective analyses, the answer to the research questions is articulated and discussed in the following subsections.

6.1 Barriers, drivers, and workarounds

The factors that hinder or facilitate *engagement in the design* and *engagement in use* are articulated in a set of barriers, drivers, and workarounds (Table 6.1), whose aim is to serve as a generative set for similar systems where human contribution is required.

Barriers	Drivers	
System stability	Unexpected gain. Opportunity	• Appropriation
Missing functionalities		• Legitimacy
		• Freedom
Usability	Expected gain	• Curiosity
Task Workflow		• Learning
		• Idealism
Workaround		
Resilience to contribute		
Resilience to communicate		
Resilience to missing functionalities		
Resilience to change		

Table 6.1: Barriers, drivers, and workarounds are the first contribution of the thesis

Furthermore, the set has been empirically identified through the two studies and, the related literature. Barriers, drivers, and workarounds were first identified in the exploratory study conducted in Study 1, and tested, improved and refined in the second and third phases in this study. Furthermore, the set was validated in Study 2 through scrutiny and careful reflexive analysis of what every study could

bring to answer the first research question: *What can facilitate or hinder engagement in co-design of collaborative systems?* The elements in this set are defined as follows:

- Barrier. Elements or interactions that hinder engagement.

- Driver. Elements or motives that facilitate engagement.

- Workaround. Strategies which emerged from participants' reflection to overcome barriers. They support engagement and favour contribution. Moreover, they suggest preferable practices and approaches of participants which can further support design.

6.1.1 Barriers

Barriers refers to those elements or interactions that hinder engagement. The barriers that emerged corresponded to: system stability, usability, task workflow, missing functionalities.

System stability, refers to the difficulties of keeping the system working, the system around which engagement is articulated. In Study 1 it referred to the issues with the server where the UI was hosted where this barrier can characterise two of the barriers identified by O'Brien and Toms (2008) namely technology issues and interruption management. In Study 2 it referred to the tensions around the two existing archives and how teachers were dealing with them, proving that, as Pedersen (2016) observed, the power dynamics can influence in the development of the co-design process.

Usability refers to the quality of the interaction with the system. In Study 1 students had difficulties interacting with the UI. In Study 2 was a major challenge: the two archives were badly organised and there was a lack of accessibility.

Missing functionalities, which refers to those factors that were missing in the system and crucial to improve interaction. In Study 1 it referred to those functionalities that hindered the interaction whereas in Study 2 it referred to those aspects that could facilitate practices when interacting with the repositories but were missing.

Task workflow, which refers to the organisation of the processes included in the system. In Study 1 it refers to task retrieval whereas in Study 2 it referred to how the process to submit materials was organised.

In the literature, Rotman et al. (2012) consider trust a barrier. In the first phase of Study 1, participants trusted neither the system nor the developers, who with they had contact through the professor. Due to the many times the system crashed, participants were frustrated and felt abandoned by the developers, as fixing the issues with the server required a lot of their time. In the second and third phases of the study, trust was not an issue because participants had a more direct contact with myself who would contact them to let them know whether the system was running or allay their doubts. Therefore, by articulating the relationship designer-practitioner, as Light (2010) pointed out, where the previous relationship between participants and developers failed, I took a different approach where trust would not be a barrier. In Study 2, trust was not a barrier that would prevent participants from engaging, because they considered the designer an expert in technology who would solve their problems with her knowledge on technology and classification.

Nonetheless, although none of the systems under study were fulfilling any of the principles of UX that, according to the literature are crucial to ensure engagement (O'Brien and Toms, 2008), engagement did not only depend on challenging tasks (Webster and Ahuja, 2006) or user characteristics and context (Hart et al., 2012). Engagement was linked to deeper motives that drove participants to keep contributing while engaged, finding alternative ways to keep contributing: that is where drivers and workarounds emerged.

6.1.2 Drivers

Drivers refers to aspects that elicit engagement, mainly related to motivation. In the two studies presented in this thesis, Curiosity (Reiss, 2004) was the starting point of the engagement process and led to other motives. As observed by Rotman et al. (2012) the initial motive evolved to different ones, namely Unexpected gains which referred to the unpredicted intrinsic benefit that a participant might obtain from engaging, namely Opportunity, also observed by (Østergaard et al. (2018)), and Expected gains, which refer to the ways participants can render their collaboration into a beneficial experience.

Unexpected gains, which was articulated ad Opportunity, is composed of Appropriation, Freedom, and Legitimation which are highly interconnected. Appropriation refers to the process of assuming the design process as the participants' own. In the studies analysed participants took ownership of their tasks as translators and evaluators, feeling responsible for the completion of their tasks. It was also observed when participants rejected my proposal and decided to participate in the co-design workshop as an opportunity to improve their practices (Østergaard et al., 2018). Legitimation, which refers to participants' ability to sharing experiences,

reflecting on them during the process of design and to be heard, was observed when participants made jokes about the failures in the system, expressing their views on the proposed mobile app, or by suggesting functionalities. During the co-design processes, Freedom, which refers to allowing participants to express themselves freely, was an essential aspect in the space created for participants to express their opinions without fear or impediments.

Expected gains, is composed of Curiosity, Learning and Ideology. Learning, was an important driver and occurred at two levels: mutual learning (Simonsen and Robertson, 2012) which happened during workshops and focus groups favouring participants' reflection, and learning at a cognitive level. For example, in Study 1, in addition to improving their knowledge of languages, students learnt that their peers have different levels of precision when translating, and completed tasks at different paces. Moreover, students reported having fun while learning, and according to Nov (2007) fun is linked to high levels of engagement. In Study 2, teachers learnt the ways other teachers work, organise, and classify their materials. They enjoyed completing the tasks in the co-design workshop, as they facilitated reflection on their practices and learning how to improve them as claimed by Nov (2007). Ideology refers to the feeling of contributing to something good for the community. Some studies claimed that Ideology might not be related to high levels of engagement (Nov et al., 2013). The studies presented in this thesis, similarly to (O'Brien and Schäler, 2010), have demonstrated that being part of the project, creating such a resource that is important for others, made participants reflect on the relevance of their work and knowledge for the community or to society in general (Dalsgaard and Halskov, 2012).

6.1.3 Workarounds

Workarounds refers to those aspects that spontaneously emerged as a way to overcome the barriers and favour engagement. When motives are moving partici-pants towards higher degrees of engagement, workarounds emerged as opportunities to keep engaged. Contrary to mitigation measures (Thinyane et al., 2018)(Doherty and Doherty, 2018), that consist of design directions or suggestions proposed by designers and researchers as a result of the designer's reflection, workarounds emerged from participants' own motivation after reflecting on the meaning of their participation in the design process and where the direction of the co-design could take them (Pihkala and Karasti, 2013). Therefore, workarounds are materialised attempts to overcome the barriers encountered during the studies, so as to keep engaged in alternative ways. Contrary to Bratteteig and Verne (2018), who claimed that participants' resilience leads to adaptation of their practices to the way the system works, workarounds emerged as alternatives to change their practices and to

engage by using different approaches. They are context dependent and participant dependent. For example, workarounds were different in Study 1 and Study 2.

Workarounds can be defined as strategies adopted to facilitate participants' engagement during the co-design process when they encounter factors that hinder their engagement. Workarounds depend on the context around which they emerge as well as on the participants involved. Hence, workarounds are the result of participant's critical reflection that allowed them to make conscious choices that would affect their practices (Sengers et al., 2005).

The four workarounds identified in these studies corresponded to:

- Resilience to contribute, that emerged when participants wanted to contribute but the system did not satisfy their desire

- Resilience to communicate, that emerged when the system did not satisfy their communication needs

- Resilience to missing functionalities, that emerged when the system did not satisfy their needs

- Resilience to change, that emerged when participants kept reflecting on their practices which hindered their improvement

6.2 Reflexivity and co-design

Traditionally, reflexivity has been researched as an orientation to analyse *engagement in the design* in PD (Pihkala and Karasti, 2013)), and investigate its evolution towards genuine participation (Østergaard et al., 2018). However, in this thesis I wanted to articulate engagement in co-design of collaborative systems with a reflexive orientation. Reflexivity considers relationships, personal expectations, and commitments in the design setting (Karasti and Blomberg, 2012). These are an essential aspect of engagement and can lead to benefits in the co-design process as claimed by Salehzadeh Niksirat et al. (2018). The design setting is deconstructed in three dimensions: system, participants, and context, that facilitate the adoption of a reflexive orientation in co-design. The dimensions are articulated as a result of the analysis of the literature, the empirical data included in this thesis and the embodied knowledge (Light and Akama, 2012) I acquired when conducting and analysing these studies. The dimension answer the third research question of the thesis: *What factors facilitate the adoption of a reflexive orientation in co-design?*

6.2.1 The system

This dimension refers to the co-designed digital system around which the participant's engagement is instrumented. Through co-design, this thesis gave voice to, and engaged, those participants whose participation and opinions are not always considered, and who were affected by the changes that the system would introduce (Marti and Bannon, 2009). On the one hand, students of linguistics who in previous studies, were considered data providers (Braslavski et al., 2014) and, on the other hand, teachers who usually accept the mandates of someone in a power position. Therefore, the system is a pivotal aspect of participants' engagement because it is the result and main aspect that influences engagement. Reflexivity supported the analysis of the relationships, commitments, personal expectations, and feelings during the co-design process (Sanders and Stappers, 2014).

In the pre-design phase, reflexivity supported the understanding of people's experience in context and their initial involvement. Participants expressed their feelings and shared previous experience with technology or with similar systems. Moreover, reflecting on previous experiences with similar systems helped them reflect on the direction of the design.

In the second phase of co-design, reflexivity supported the analysis of the generated ideas. Prototypes were the means to engage them as well as to articulate their needs and expectations.

In the third phase of co-design, reflexivity supported the analyses of the evaluation by observing feelings that emerged during system testing, tensions emerged during peer-review evaluation, feelings while understanding each others designs, commitments to create alternative indeces, and expectations on the adoption of the designs.

In the last phase, post-design, reflexivity supported the analysis of people's experience after the co-design process. Students' diaries reflected their *engagement in use* as well as their difficult relation with it. In Study 2 the people in power positions imposed their will and negotiation was not an option.

6.2.2 The participant

Reflexive engagement involves the researcher as a participant questioning where participation is and how to enhance it in specific contexts of design (Pihkala and Karasti, 2013). Moreover, researchers and participants should engage in the critical reflection of the design space (Karasti and Blomberg, 2012). Engaging participants

means allowing them to be themselves, express themselves, and be immersed in the participatory process (Østergaard et al., 2018).

The reflexive orientation facilitated the identification of feelings caused by issues around the systems, and hence influenced the design choices (Salehzadeh Niksirat et al., 2018). Reflexivity in Study 1 facilitated the understanding of the causes of participants' frustration and the articulation of the barriers, drivers, and workarounds. Moreover, in Study 2, participants articulated their disappointment and expectations from technology side as well as from their participation. The critical analysis of the design space (Sengers et al., 2005), understanding the relationships and the feelings of all participants, facilitated the redirection of the research. Moreover, the designer facilitated participants' reflection (Light and Akama, 2012), and they understood our relationship as an opportunity to move forward to a more digital solution.

6.2.3 The context

Co-design does not happen in a vacuum, therefore, this dimension reflects on the relationships around the co-design process that influenced it (Pedersen, 2016). Understanding the social environment to better engage users beyond cognitive involvement would benefit the understanding of contextual factors in projects where volunteer contribution is required (Hamari et al., 2014).

The adoption of a reflexive orientation facilitated a thoughtful and careful attention to the relationships as well as the emotional load that the issues addressed in the thesis implied for participants.

During the design process several unexpected circumstances emerged, such as earthquakes, personal issues, and work commitments that limited the engagement of some participants. Moreover, tensions between people in power positions and participants were observed and carefully treated offering space for dialogue.

6.2.4 Validity of reflexivity

As argued in the literature, several authors have exposed their arguments against reflexivity as a valid method for research (Pillow (2003)) (Lynch, 2000). In this subsection, I want to argue for the case of reflexivity as a valid orientation to investigate engagement in co-design.

First of all, contrary to what Lynch (2000) suggested about the lack of method, in this thesis the process of reflexivity followed a method guided by i) the research

	Method	Quantity
Study 1	Semi-structured interview	6 transcriptions
	Desktop registration of interaction	6 records
	Think aloud protocol	6 transcriptions
	Word file with email extracts	1 document
	Paper prototypes	72 paper sketches
	Focus group	2 transcriptions
	Video-recording of the co-design session	12 video extracts
	Emails	95 emails
	Diaries	3 diaries
	Log file	2 files
	Questionnaire	6 responses
Study 2	semi-structured Interviews	8 Transcriptions
	Phone interviews	8 transcriptions
	Focus group	1 transcription
	Informal interviews	12 observations
	Posters	82 sticky notes
	Emails	36 emails
	Mobile app evaluation	7 observations
	Co-design session	3 prototypes, 15 activities completed, 3 audio-recorded sessions
	Fieldnotes	3 paper sketches and notes produced by participants
	Prototype evaluation	3 audio-registrations
	Observations	28 hours
	Document analysis	Field notes, National study plan, Provincial study plan, two school study plans, one set of guidelines on teachers' regulation, two publications on teaching in the bilingual project, and 26 study plans.

Table 6.2: Methods researched in both studies

process adopted in the thesis proposed by Steen (2013); and ii) followed a qualitative research methodology with an interpretative approach (Klein and Myers, 1999),

where different qualitative methods have supported and enlightened the argument (Kaplan and Maxwell, 2005) and discussion of events, considering relationships and feelings manifested and reported by participants, as well as those observed by the researchers (Table 6.2).

Second, Pillow (2003) argued that reflexivity provides a positivist approach to research, seeing success in failure. I will argue this claim with an example: in Study 2 I proposed that participants create the classification of their materials through a mobile app. However, they rejected it as it was not fulfilling their needs and expectations. In a situation like this, the research could have stopped: I have a failure case, but I can learn something from it. However, I analysed the situation and considered that I had a group of teachers who knew each other and knew what the problem was. Moreover, they were willing to change things but they needed help. Furthermore, they were frustrated because changes were hard to introduce in the institution. In this situation, I could have stopped the research. Instead, I decided to continue and do something productive with them. After analysing the situation in a retrospective manner, the relationships among teachers, my relationship with them, their enthusiasm and will to improve, as well as what the failed case brought about, facilitated the redirection of the research.

The next section introduces the main contribution of the thesis, where these dimensions and the set of barriers, drivers, and workarounds are intertwined in a framework to understand engagement in co-design of collaborative systems with a reflexive orientation.

6.3 Conceptual framework

The third contribution of this thesis is a framework to investigate engagement in co-design. The framework is motivated by the interest in investigating engagement understood in two different approaches: *engagement in the design* and *engagement in use*. The framework is the result of adopting a reflexive orientation in the analysis of co-design projects. It is based on the retrospective analysis of the empirical work described in this thesis and the literature reviewed on co-design, UX, and motivation. Including studies on co-design (Steen, 2013)(Vines et al., 2013)(Pedersen, 2016)(Østergaard et al., 2018), UX (O'Brien and Toms, 2008)(Dittus et al., 2016), and motivation (Reiss, 2004)(Rotman et al., 2012)(Nov et al., 2013). This framework identifies and articulates elements that are characteristic in the understanding of engagement in collaborative systems and provides a comprehensive tool to understand engagement on different dimensions.

The dimensions which compose this framework correspond to the dimensions articulated to facilitate the adoption of a reflexive approach: the system (Marti and Bannon, 2009), the participant (Pihkala and Karasti, 2013)(Karasti and Blomberg, 2012), and the context (Pedersen, 2016)(Hamari et al., 2014). These dimensions can further guide researchers in the analysis of the design process. In this way, engagement can be understood as a multifaceted variable where each of these dimensions provides a different, but complementary, perspective.

Moreover, the investigation of co-design in two different studies, as an evaluative task and as a participatory process, highlighted a number of factors that hindered or facilitated engagement and that are articulated as barriers, drivers, and workarounds. More specifically, the factors identified as barriers were:

- System stability, which refers to the difficulties of keeping the system working, the system around which engagement is articulated.

- Missing functionalities, which refers to those factors that were missing in the system and crucial to improve interaction.

- Usability, which refers to the quality of the interaction with the system.

- Task workflow, which refers to the organisation of the processes included in the system.

The factors identified as drivers were:

- Unexpected gain refers to the unpredicted gain that participants could take of the project and that here was articulated as Opportunity. It was composed of:

  - Appropriation, which refers to the process of assuming the design process as the participants' own.

  - Legitimation, which refers to participants' ability to sharing experiences, reflecting on them during the process of design and to be heard.

  - Freedom, which refers to allowing participants to express themselves freely.

- Expected gains that refers to the personal reward that participants receive when participating. It was composed of:

  - Curiosity, which is the first driver to start the process of engagement.

- Learning, which refers to what participants can acquire from a cognitive level.

- Idealism, which refers to the feeling of contributing to something good for the community.

Finally, workarounds corresponded to:

- Resilience to contribute, that emerged when participants wanted to contribute but the system did not satisfy their desire.

- Resilience to communicate, that emerged when the system did not satisfy their communication needs.

- Resilience to missing functionalities, that emerged when the system did not satisfy their needs.

- Resilience to change, that emerged when participants kept reflecting on their practices which hindered their improvement.

The set of barriers, drivers, and workarounds has informed the articulation of the questions that compose this framework. The questions contemplate factors that can hinder or facilitate engagement in each dimension. They are clustered in themes according to specific aspects observed during the retrospective analyses of the two studies. Furthermore, these questions are intended to guide the reflexive process and serve as a generative tool for researchers, designers, and practitioners in the design of collaborative systems to enhance engagement.

It should be noted that the potential impact of the adoption of the framework may be limited to those projects where the modality of participation can be classified as witting or spectator-like. This excludes those participants who contribute unwittingly, that is, those participants who are not completely aware of their contribution. Moreover, the project under development should not be conducted in a controlled setting, so that the three dimensions can be easily identified. A direct contact with participants in their natural setting allows researchers to identify the different dimensions and how they are entwined, facilitating the co-design of a resource that will be more suited to participants' needs. Yet, some people in power positions or those people that do not actively participate but still have something to say need to be properly addressed and engaged in the design process. To that end, a set of actionable measures that can support the integration and engagement of other voices in the co-design process is still lacking allowing other degrees of participation (Vines et al., 2013) (Pedersen, 2016) together with a set of measures to assess the

positive impact of participant engagement on the quality of the resource created (Kirov et al., 2016) and its maintenance (Bond and Foster, 2013). Compared to other similar approaches, the framework proposed by (O'Brien and Toms, 2008) informs engagement based on system attributes, such as feedback, challenge or sensory appeal, and affective user characteristics. However, this framework is used to inform engagement considering witting participation where other types of participation are not considered. Moreover, whereas this framework considers attributes that are characteristic in digital systems aimed at engaging participants in use, the context around which engagement is articulated is not considered.

The following paragraphs describe how dimensions and the set of barriers, drivers, and workarounds are intertwined to compose the framework (Table 6.3).

6.3.1 The system

This dimension refers to what is to be co-designed and, therefore, to what participants have to contribute. In this dimension, questions are clustered according the barriers identified. These themes are:

- Technology, to facilitate reflexivity on the technology to be designed. This theme emerged from the barrier System stability to understand what has to be considered when designing with respect to technology.

- Technology and participants, to facilitate reflexivity on the relationship between participants and the use they do of technology, and their needs. This theme emerged from aspects observed in the barriers Usability and Task workflow to understand participants' previous experience, usage, and feelings with respect to technology.

- Technology in use, to facilitate reflexivity on the technology that participants are currently using. This theme emerged from aspects observed in the barriers Usability and Missing functionalities with respect to the quality of the interaction and the functionalities included.

6.3.2 The participant

Another dimension of the framework refers to the people being involved. In this dimension questions are clustered in five themes:

- Initial motivation, to facilitate reflexivity on the nature of engagement and the initial motivation. This theme emerges from combining aspects from Unexpected and Expected gains to understand what engages participants in the beginning of the co-design process.

- Lasting motivation, to facilitate reflexivity on what keeps participants engaged. This theme emerges from aspects observed in Unexpected and Expected gains to understand what engages participants in the co-design process in the long term.

- Resilience, to facilitate reflexivity on alternatives ways to keep engaged. This theme emerged from the workarounds observed.

- Spontaneity, to support reflexivity on unexpected behaviours that would lead to alternative ways to keep engaged. This theme emerged from workarounds to understand what barrier moved participants to act spontaneously.

- Feelings and relationships, to facilitate reflexivity on participants feelings during the co-design, what is the root of such feelings, and the relationships involved in the co-design. This theme emerged from the observations in the set of barriers, drivers, and workarounds.

6.3.3 The context

The context refers to understanding the surrounding aspects of the co-design process which can help to understand why issues are unfolding in a certain direction or why the process of engagement is developing in a specific direction. This dimension is composed of three themes:

- Sociotechnical context, to facilitate reflexivity on the location of the project. This theme emerged from the Unexpected gains to understand the nature of the design process with respect to where it is being conducted.

- Communication, to facilitate reflexivity on the way relationships can be built and maintain. This theme emerged from aspects of the Unexpected gains to keep participants engaged in the design process while facilitating relationships.

- Empathy, to facilitate reflexivity on the personal circumstances of participants that might influence the design space and the diverse ways of participation. This theme emerged from the driver Unexpected gains to facilitate the co-design process and facilitate the adoption of a flexible methodology.

Dimension	Key question

The system	**Technology.**
	• What is the aim of the technology to co-design?
	• What type of technology would be involved in the co-design process?
	    – Open source / copyrighted technology
	    – Existing technology / new technology
	
	Technology and participants.
	• What was participants' previous experience with technology?
	• How often do participants use technology?
	• What technology have they previously used?
	• What have they used it for?
	• How have they used it?
	• What type of applications do they normally use?
	• What are their impressions of that technology?
	• In what ways does technology support participants' practices?
	• Does technology fulfill participants' needs?
	
	Technology in use
	• Does technology follow the principles of usability (efficiency, effectiveness and satisfaction)?
	• Does technology include all the functionalities requested by participants?

The participant	**Initial motivations** • What are participants' needs or interests? • What are the issues around those needs or interests? • How can co-design provide a solution to those needs or further motivate those interests? • Who might be interested in participating? **Lasting motivations.** • What can participants obtain from sustained use? • What are the motives triggered by the design process? • Are the motives collective or individual? • Does motivation change?

	Resilience.
	• What do participants do to keep engaged in the co-design process?
	• What do participants do to keep contributing?
	Spontaneity
	• How to elicit spontaneous behaviour?
	• What types of spontaneous behaviour can arise during the co-design process?
	Feelings and relationships.
	• What is the relationship among participants?
	• What is the relationship between the participants and the designer?
	– How to build a trust relationship between participants and designers?
	• What are participants' feelings during the design process?
	• What are participants' feelings during the evaluation of the co-designed digital tool?
	• What is the relationship between specific feelings and interaction?
	• Can feelings be transformed into actionable design directions?
	– If yes, what are those actionable design directions?
The context	**Sociotechnical context.**
	• What type of institution is involved in the co-design process?
	– public sector/private/corporation/SME
	• What type of activity does it develop?
	• What is the aim of the group where the co-design project is taking place?
	• What are there policies or rules that influence participants activity? (National policies/local policies/institutional policies)
	• Is the powe equally distributed among the people involved in the co-design?
	– In what aspects do they influence the development of the co-design?

	Communication.
	• What are the means of communication available?
	• What is the most suitable means?
	  – Face-to-face / email / phone / instant messaging / Skype
	• What is the aim of communication?
	• How should I communicate?
	  – Formal / Informal
	
	Empathy.
	• What other duties have participants away from the design space?
	  – What is the workload of the participants in their daily lives?
	  – What is each participant's schedule?

Table 6.3: Dimensions and benefits in the adoption of reflexivity in co-design

6.4 Contribution

The retrospective analysis of the studies following a reflexive orientation brought to the formalisation of three contributions, (Figure 6.1), described below.

- A set of barriers, drivers, and workarounds to engagement in co-design. Barriers correspond to those factors that hindered engagement, drivers correspond to those factors that facilitated engagement, and workarounds correspond to strategies adopted to facilitate participants' engagement during the co-design process when they encounter factors that hinder their engagement. Workarounds depend on the context around which they emerge as well as on the participants involved. This set serves as an orientation for similar systems.

- Three dimensions that guide the adoption of reflexivity in co-design. These three dimensions support the understanding of relationships, commitments, personal expectations, and feelings facilitating the adoption of a reflexive approach throughout the design process in three main areas: the system, which refers to the co-designed artefact around which participants' engagement is instrumented; the the participants, which refers also to the participants and the researcher as a participant; and the context, which refers to the social context around which co-design is taking place.

- A framework to investigate engagement in co-design. The framework is motivated by the interest in investigating engagement understood in two different approaches: *engagement in the design* and *engagement in use*. It is based on the empirical work described in this thesis and the comparison with the literature on co-design, UX, and motivation. The framework identifies and articulates elements that are characteristic in the investigation of engagement in co-design processes and it is the result of merging the set of barriers, drivers, and workarounds with the set of dimensions. Each of the dimensions is composed of questions clustered in themes according to specific aspects observed during the retrospective analyses of the two studies and guide the reflexive process. The framework is intended to be a generative tool for researchers, designers, and practitioners in the design of systems to investigate engagement.
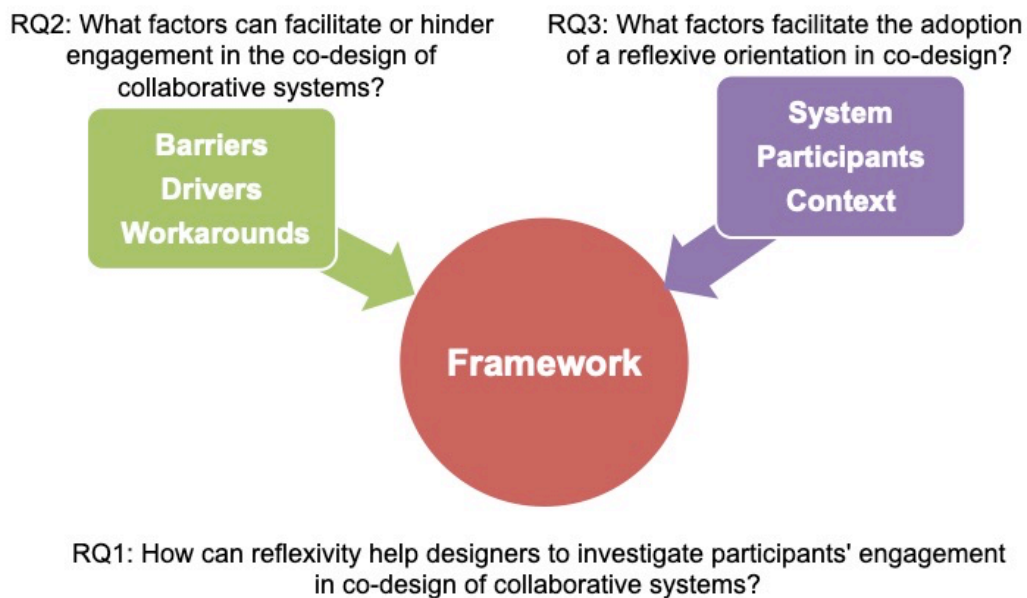
Figure 6.1: Thesis contribution
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Conclusion

This chapter presents the conclusions and the lessons learnt during the research process, the limitations, and the suggestions for future directions of the work presented.

7.1 Conclusions and lessons learnt

This thesis has investigated engagement, *engagement in the design* and *engagement in use*, in the co-design of collaborative systems with a reflexive approach. To this end, the thesis followed a qualitative approach that facilitated observation and reflection, as inspired by co-design, UX and motivation communities. Through the retrospective analyses of the two studies reflexisivity supported the analysis of relationships, personal expectations, commitments, and feelings. This investigation has led to three contributions: i) a set of barriers, drivers, and workarounds to engagement; ii) a set of dimensions to facilitate the adoption of a reflexive approach in co-design; and iii) a framework to investigate engagement in the co-design of collaborative systems. This thesis contributes to the body of research that investigates engagement in collaborative systems, namely human-in-the-loop and co-design.

Engagement in this thesis was understood from two different perspectives:

- *engagement in the design*, the commitment people feel when taking part in a design project. In this case, engagement refers to the commitment participants feel for the project they have been involved in

- *engagement in use*, the motivation which drives the users in the interaction with a system. In this case engagement refers to the psychological state needed to foster human contribution to computing systems, specifically in the form of data, as well as to the psychological state of being immersed in the interaction associated to specific interface features

Acquiring understanding from two studies where engagement in collaborative systems is approached from two different co-design perspectives, namely, user-centric perspective and participative perspective, I learnt distinct things about engagement.

First, I learnt that when participants contribute they are engaged by deep motives related to expected gains, such as the personal gain resulting from their participation, and that they can be engaged by unexpected gains, such as the opportunity to improve aspects of their practice.

Second, when participants want to contribute and they encounter barriers, they find their own strategies to keep engaged.

Third, no matter what the difficulties encountered, if their personal gain is greater than those difficulties, they will remain engaged.

Finally, an interesting factor that emerged from the studies, and that was not identified in any of the studies reviewed in the literature described in chapter 2 corresponded to workarounds. Contrary to mitigation measures, Workarounds emerge when participants encounter factors that hinder their engagement. Workarounds can be defined as strategies adopted to support participants' engagement during the co-design process. Moreover, workarounds depend on the context around which they emerge as well as on the participants involved. Hence, workarounds are the result of participant's critical reflection that allowed them to make conscious choices that would affect their practices.

7.2 Limitations

The work presented in this thesis has several limitations. First, the data presented in both studies was analysed retrospectively. This forced me to rely on the data that was collected for purposes other than answering my research question, which might have caused me to miss a glimpse of the relationships or the feelings which emerged while collaborating with the participants. If the data and research could have been conducted in line with the research question, the results would have probably been different.

Another limitation refers to the incentives that were provided by the institutions on their own initiative in the co-design processes. In the case of the students, although the selected reward corresponded to credits, these did not attract the attention of many students and the groups were small. In the case of the teachers, some of them felt coerced by the proposition of money in exchange for an extra workload. Tensions existed between the people in power positions and the teachers who were overwhelmed and were in precarious situations. Some teachers felt that my proposal was a way to make them work for a task that no one wanted to do in exchange for a low economic reward. The intervention of the people in power

positions in this sense might have had a negative effect on the number of participants and the way the proposal was perceived.

7.3 Future work

Regarding the framework, it would be interesting to investigate its effectiveness in other settings. One example could be, in a non-italian context, to understand the influence of different cultural backgrounds and how relationships evolve, investigating whether the framework needs to be revised in order to accommodate other realities.

Another possible future endeavour would be to investigate the adoption of the co-designed collaborative system designed with the framework to investigate whether the number of contributions increases, not only in those participants involved in the co-design process, but also in other people who were not involved.

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