Doctoral Dissertation

Supporting Learner Centered Vocabulary Learning in Informal Learning Environments

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Abstract

Acquiring a large vocabulary is one of the first and most important steps of foreign language learning. In fact, vocabulary knowledge leads to more vocabulary knowledge thus learning vocabulary efficiently is important to improve the language learning process. Learning the vocabulary efficiently include taking into consideration the specific vocabulary needs of the language learners. Current language learning materials do not take into account the specific vocabulary needed by the learner. Learning materials are generally standardized and usually provide the most "common vocabulary".

The challenges faced by vocabulary learners are not limited to the vocabulary they learn. Often, language learners translate words from/to the target language. But words can have several meanings depending on the context of use. Learners do not have the opportunity to indicate the meaning of the word they are looking up and receive a translation that fits their particular interests or activities.

Another challenge faced by language learners relates to the understanding of the target vocabulary. Whether they are learning a new vocabulary list, or translating it, learners need to understand the target words. Most of words are easy to understand as they have an equivalent in the learners' native language. However, some words are non-translatable and specific to a certain language or culture. Many of those words are culturally specific. To understand them, learners might refer to dictionaries or images. The explanation provided by those tools is probably independent of the learner's own culture and might leave them with the inability to fully understand the culturally-specific vocabulary.

Current vocabulary instruction is not adapted to the learners' particular needs, context or previous knowledge. Today, information technologies are widely used to learn a language informally. Informal learning happens outside of the classroom, often using technologies, and gives the learner complete control over the content they choose to learn, their learning activities as well as their assessment methods. Mobile technologies, constant internet connection, and the availability of learners' data can provide ubiquitous learning environments and offer an opportunity to design learner-centered tools to support informal vocabulary learning. In the context of informal language learning, learner-centered learning refers to methods that recognizes difference in individual needs and characteristics of the learners.

This research proposes methods that take advantage of available learner data to sup-

port learner-centered informal vocabulary learning. When learning informally, the language learner needs to select the vocabulary to learn, translate vocabulary from the target language, and understand the vocabulary of the target language. Each of these activities could pose a challenge to the learner.

First, language learners have often difficulties selecting the vocabulary to learn based on their goals and particular needs across the available standardized material. Second, learners often need to translate words from the target language. However, words often have different meanings, and in an informal learning environment, learners cannot express which meaning is the most appropriate to their current activity or interest. Finally, some words like sumo, sushi or schnitzel are culturally specific, and the language learner can have difficulty understanding them as they don't have an equivalent in the learner's native culture.

This work aims to tackle each of those challenges. Participatory design methods are used to show that different language learners have different vocabulary learning needs. To support the selection of the vocabulary based on the learner's needs, a method is proposed to recommend vocabulary to learners using their past learning activity. To support the translation of vocabulary from the target language, a method is proposed to disambiguate the intended meaning of the learner based on their past learning activity. Finally, to support the understanding of non-translatable foreign terms, a method is proposed to explain the target vocabulary based on the previous knowledge of the language learner.

The proposed methods can inform the design of an learner-centered informal language learning system. Following the methods, designers can support language learners in three of the main informal vocabulary learning activities: selecting words, translating words and understanding words.

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Chapter 1

Introduction

Learning a foreign language has become an integral part of the life of a a large number of people in the world, due to advances in globalization, ease of transport, and international exchange. Acquiring a large vocabulary is one of the first and most important steps of foreign language learning [8]. A rich vocabulary makes the skills of listening, speaking, reading, and writing easier to perform [79]. Most importantly, vocabulary knowledge leads to more vocabulary knowledge: knowing words allow people to use and practice the language, which leads to an increase in vocabulary [78]. Consequently, learning vocabulary efficiently is important to improve vocabulary knowledge and the language learning process.

Learning the vocabulary efficiently means learning the most useful vocabulary first [78]. However, the most useful vocabulary for a particular learner depends on the learner herself. For example, a foreign exchange student in Japan would need to learn the necessary vocabulary related to his field of study, whereas a consultant on a business trip to Italy would need to learn the vocabulary that can get her through the meetings, and potentially help her find good cheese in the supermarket.

Current language learning materials do not take into account the specific vocabulary needed by the learner. Learning materials are generally standardized and usually provide the most "common vocabulary". This list of vocabulary is often based on the most frequent words used by native speakers [6]. However, native speakers' conversations do not necessarily answer the communication needs of foreign language learners. Language learners can find it difficult to learn words that allow them to achieve their goals and express their personal culture, interests or activities. For example, the word 'fridge' is one of the most commonly used words by native speakers, as it is often used within a

household. On the other hand, a foreign language learner, even one immigrating to a foreign country, would rarely need the word 'fridge', as they would probably be living alone or in a household where the target language is not spoken.

The challenges faced by vocabulary learners are not limited to the vocabulary they learn. Often, language learners translate words from/to the target language. But words can have several meanings. For example, the word fan can mean $ventilator$ or $admirer$ depending on the context of use. Learners do not have the opportunity to indicate the meaning of the word they are looking up and receive a translation that fits their particular interests or activities.

Another challenge faced by language learners relates to the understanding of the target vocabulary. Whether they are learning a new vocabulary list, or translating it, learners need to understand the target words. Most of words are easy to understand as they have an equivalent in the learners' native language. However, some words are non-translatable and specific to a certain language or culture, e.g.: sumo, sushi, schnitzel. Many of those words are culturally specific. To understand them, learners might refer to dictionaries or images [87]. The explanation provided by those tools is probably independent of the learner's own culture and might leave them with the inability to fully understand the culturally-specific vocabulary.

The presented scenarios show that language learners face challenges when selecting, translating or understanding vocabulary. In fact, current vocabulary instruction is not adapted to their particular needs, context or previous knowledge.

Today, information technologies are widely used to learn a language informally. Informal learning happens outside of the classroom and gives the learner complete control over the content they choose to learn, their learning activities as well as their assessment methods [25]. Vocabulary learning takes place informally 80 % of the time [71], often using technologies [44]. Mobile technologies, constant internet connection, and the availability of learners' data can provide ubiquitous learning environments and offer an opportunity to design learner-centered tools to support informal vocabulary learning. In the context of informal language learning, learner-centered learning refers to methods that recognizes difference in individual needs and characteristics of the learners.

This research proposes methods that take advantage of available learner data to support learner-centered informal vocabulary learning. When learning informally, the language learner needs to select the vocabulary to learn, translate vocabulary from the target

language, and understand the vocabulary of the target language. Each of these activities could pose a challenge to the learner.

First, language learners have often difficulties selecting the vocabulary to learn based on their goals and particular needs across the available standardized material. Second, learners often need to translate words from the target language. However, words often have different meanings, and in an informal learning environment, learners cannot express which meaning is the most appropriate to their current activity or interest. Finally, some words like sumo, sushi or schnitzel are culturally specific, and the language learner can have difficulty understanding them as they don't have an equivalent in the learner's native culture.

This work aims to tackle each of those challenges. In chapter 3, participatory design methods are used to show that different language learners have different vocabulary learning needs. chapter 4, aims to support the selection of the vocabulary based on the learner's needs. To do so, a method is proposed to recommend vocabulary to learners using their past learning activity. Chapter 5 aims to support the translation of vocabulary from the target language. To this end, a method is proposed to disambiguate the intended meaning of the learner based on their past learning activity. Finally, to support the understanding of non-translatable foreign terms, a method is proposed to explain the target vocabulary based on the previous knowledge of the language learner. Figure 1.1 illustrated the different informal activity, its associated problems and the learner-centered solution that is proposed.

The proposed methods can inform the design of an learner-centered informal language learning system. Following the methods, designers can support language learners in three of the main informal vocabulary learning activities: selecting words, translating words and understanding words.
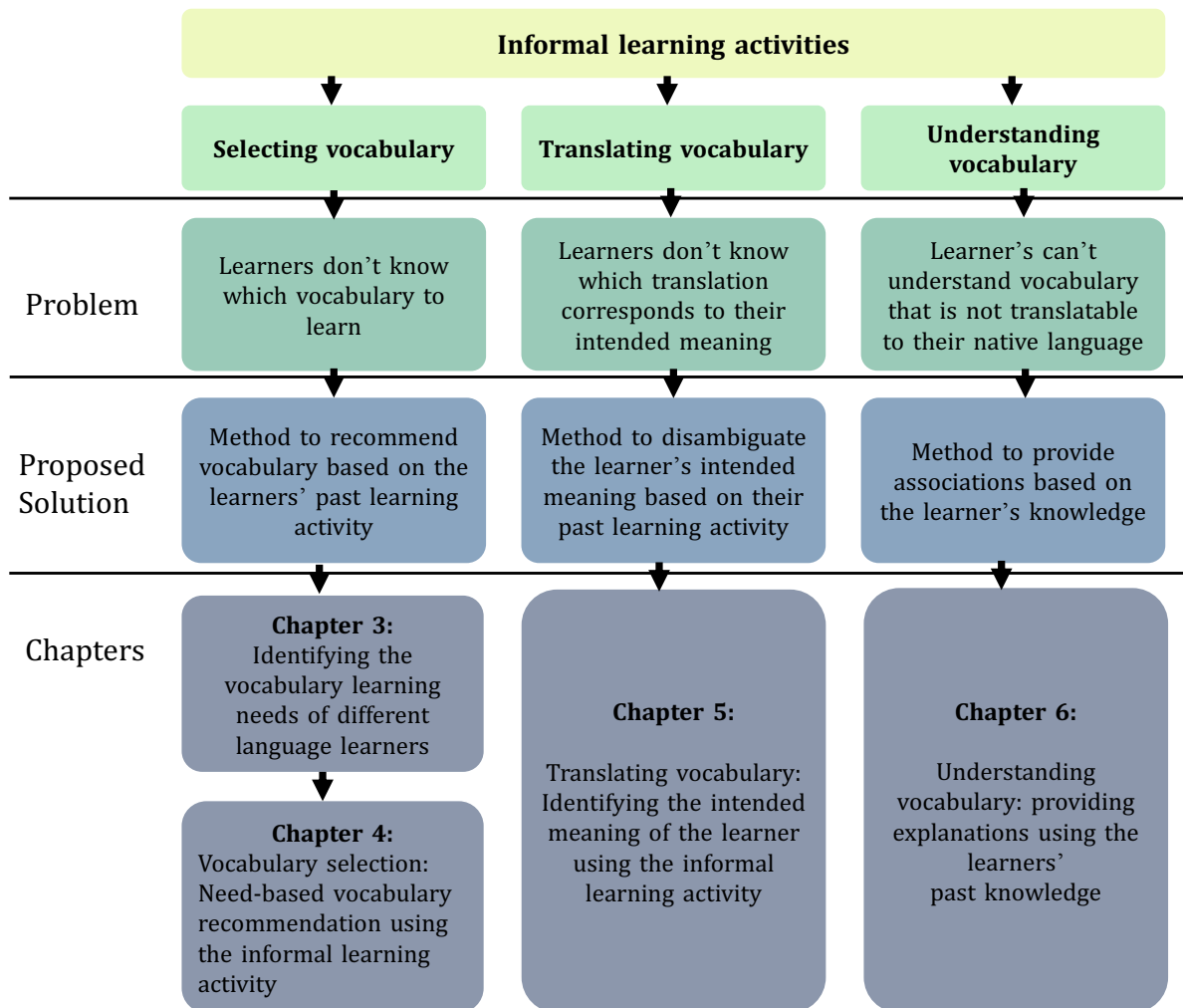
Figure 1.1: Thesis overview: Informal learning activities, associated problems and proposed solutions

Chapter 2

Learner-centered informal vocabulary learning

2.1 Vocabulary learning tools

Acquiring a large vocabulary is one of the first and most important steps when learning a new language [8]. As Wilkins argues, "without grammar, very little can be conveyed; without vocabulary nothing can be conveyed" [111]. A rich vocabulary improves the skills of listening, speaking, reading, and writing [79]. Moreover, vocabulary knowledge leads to more vocabulary knowledge: knowing words allow people to use and practice the language, which leads to an increase in vocabulary [78].

Curriculum writers and educators have always been aware of the importance of vocabulary in language learning and provided language learners with extensive vocabulary lists that include the most frequent words. For instance, a well-known study showed that the 5000 most frequent English words provide more than 95% vocabulary coverage included in daily English conversations [6]. The results of this study and several similar studies were extracted by analyzing the discourse of native speakers. However, second language learners often have specific goals that push them to learn a new language and their target conversations might not resemble the everyday conversations conducted by native speakers. For example, second language learners might want to learn the specific vocabulary related to the topic they will study abroad, or the vocabulary related to Karate that they want to practice in Japan.

Today's vocabulary instruction is standardized and independent from the target individual, group or population and does not take into account the different needs of language learners. This reality is rooted in the pre-computer era when language learning materials

and methods needed to be standardized to fit the "typical" learner. In fact, language learning books provide a fixed vocabulary curriculum, and learners have to find the vocabulary they need among it. Today, even though around 84% of language learning applications focus mainly on vocabulary learning [44], the curriculum provided is still standardized and does not consider different language needs through individual differences. Even the most downloaded language learning mobile applications, like Memrise or Duolingo, provide different learners with the same set of words to learn. However, the technologies available today, the constant internet connection, and the availability of learners' data, offer an opportunity to design tools that correspond to different language learners.

2.2 Informal language learning environments

Vocabulary learning takes place formally or/and informally [71]. Formal learning is an education that is normally delivered by teachers in a systematic intentional way within a school, a higher education or a university. The goal of formal learning is to get the learner to learn the fixed curriculum [103]. Contrary to formal learning, in an informal learning setting the learner has complete control over the content they choose to learn, their learning activities as well as their assessment methods [25].

Informal language learning constitutes a major part of learning [71]. Informal learning has been compared to the mostly invisible surface of the iceberg as it constitutes 80% of learning, while formal learning has been compared to the tip of the iceberg as it constitutes only 20% of learning [71]. Informal learning is often associated with the use of technologies for foreign language learning. In fact, more than 90% of surveyed language learners use their mobile phones informally for their learning activities [29]. One important aspect of informal learning tools is that the context is constructed by learners through interaction. Learners choose to learn words inspired by their surroundings, interests, and goals [98]. Even though most of the vocabulary learning happens informally, the focus of previous research has been directed towards instructor-centered approaches where the instructors develop the content, and design the learning scenarios and activities [24].

2.3 Learner-centered vocabulary learning

Learner-centered learning was given different definitions depending on the context. In the context of formal learning, a learner-centered approach shifts the focus of instruction from

the teacher to the learner and is used as opposed to a teacher-centered approach. Learner-centered or personalized learning can also refer to instructional methods that recognize the learning needs, interests, aspirations, or cultural backgrounds of individual learners [65]. In this work, the second definition is adapted and the usage of learner-centered refers to methods that recognize differences in the learners' individual characteristics.

A learner-centered design approach, where diversity and individual differences would be considered to optimize learning, has been promoted as essential for quality education. However, most of the previous research on language learning technologies explored other aspects like learners' perceptions of language learning to show that mobile technologies are positively perceived and accepted by learners. A number of previous studies also focused on learning behaviors related to mobile learning environments [97].

Language learning tools are currently evolving to support learner-centered learning. However, learner-centered learning is highly dependent on the learners' characteristics that are taken into account. Learners' characteristics have been defined in terms of personal attributes, learning contexts, previous knowledge, and skills [99]. Previous work and language learning tools focused on learning characteristics such as the learning pace, user involvement, individual abilities, and learning memory cycles, all of which fall in the categories of learning contexts, knowledge, and skills. However, since vocabulary learning is personal as it depends on the culture [72], purpose and interests [38] of the learner, a learner-centered education taking into consideration the personal characteristics and needs would be beneficial for the learning. However, even though available mobile tools create an opportunity to support language learning based on personal attributes, there is a clear lack of research related to the topic. Mobile language learning tools are even less effective in providing learner-centered language learning. Indeed, most informal language learning applications are standardized and offer learners materials and methods regardless their needs or goal that triggered the learning of the new language.

2.4 Informal language learning environment: SCROLL

The informal language learning environment used in this study is the SCROLL system, (System for Capturing and Reminding Of Learning Log). SCROLL is a digital record of what language learners learn in their daily lives. SCROLL's users create an account and log the vocabulary they wish to learn. SCROLL allows users to capture the contex-

tual data when learning a new word – users can log the new word they learned, get its translation, save the time of insertion, an image, a video, and their current location [83]. SCROLL is free to use and currently has 1705 registered users. It also contains around 30380 logs [84], 34.2% of which have a location associated to them. Most SCROLL users live in Japan and use it to informally learn English or Japanese. Most of SCROLL's users do not upload an image when creating a new log. Only 18.6% of logs are created with images associated with them [42].

Figure 2.1 is a screenshot from SCROLL that shows a log inserted by a learner for the word *book*. The user attached an image and a location when creating the log. A Japanese and a Portuguese translation of the word *book* was automatically provided to the user, and the time of input was automatically saved. In SCROLL, users save a new word they want to learn, depending on their specific context. The time and location are saved automatically, and the user can attach an image to the log. The user also have access to their previous logs, and can look at other users' logs. In figure , The learner translated the word *book* from Japanese to Portuguese, and uploaded the picture of a book.

Figure 2.1: Screenshot from the SCROLL system showing a log inserted by a user

Chapter 3

Identifying the vocabulary learning needs of different language learners

3.1 Introduction

3.1.1 Need analysis for informal language learners

The analysis of the learners' needs is a considerable factor in determining a successful design of language learning tools and activities [56]. Language learners have different purposes and goals behind learning a new language, thus different language learning needs. Previous studies on need analysis are mostly conducted in a formal learning setting and interrelated with course design, teaching, and assessment evaluation [32, 56]. No previous work tackled the informal vocabulary learning needs of different individuals or groups of language learners. This work aims to first demonstrate that language learners have different vocabulary learning needs depending on their life situations and goals. Moreover, it plans to extract those needs using participatory design methods.

3.1.2 Case study: refugees in different stages of migration

In order to extract the vocabulary learning needs of language learners we chose to focus on refugees as a population. Refugees are often seen as one single group of language learners. However, different refugees are in different stages of migration which entail different life situations and different needs [30]. Whether they are in a transition country waiting to relocate or settled in their destination country, language learning is often an essential part of their journey. Previous work has been conducted to support the language learning activities of refugees. It is mainly aimed at supporting their learning of the local language of the host country to facilitate their social inclusion process, e.g.,

learning German in Germany [5, 82]. These studies provide valuable insights regarding the language learning of refugees who are settled in their final destination. However, the effects of forced emigration vary greatly from one refugee group to another [43]. Therefore, when developing language education tools for refugees, it is important to take into account their unique living conditions and the particular circumstances that drove them to learn a new language [60]. Thus, different refugee groups require different considerations when designing language learning tools. Identifying the unique needs of refugees in different stages of migration is essential to provide them with better language learning tools.

Throughout their unstable journey, most of the refugees have access to smartphones [39]. In this scheme, smartphones present them with opportunities for informal language learning. In this study, we aim to understand the needs of Syrian refugees in Lebanon and Germany in order to provide them with adapted language learning tools. Syrian refugees in Lebanon and Germany are in different life situations and stages of their journey. A big part of Syrian refugees in Lebanon are transition. Moreover, they speak Arabic; Lebanon's official language. However, young Syrian refugees in Lebanon are trying to study English [22, 92] to facilitate their immigration to a safer country with better education opportunities and higher respect for human rights [108]. Moreover, for Syrian refugees in Lebanon, studying a language that is not locally spoken, can hinder their learning. On the other hand, Syrian refugees in Germany are learning German to better integrate and settle in their new host country. The German government provides them with free German classes, and they benefit from being continuously exposed to the German language.

3.1.3 Goals of the study

To inform the design of language learning tools for Syrian refugees, this work aims to understand and compare the tacit and latent needs of Syrian refugees transitioning in Lebanon and the ones settling in Germany. The research question that this work aims to answer is: What are the needs of Syrian refugees in Lebanon and Germany in regards to learning languages using mobile language tools? To identify these needs, we use Participatory Design (PD) techniques. By involving the end users of a technology in its design [76], PD can help elicit the tacit and latent needs of future users [50, 51, 109]. We present the findings of a two-part participatory design study with eight Syrian refugees interested in learning English in Lebanon and ten Syrian refugees learning German in Germany. We compare their different needs and discuss the challenges of meeting them using mobile

tools. The results of this study could lead to an informed design of a language learning tool for Syrian refugees to use throughout the different stages of their journey.

3.2 Related work

3.2.1 Motivation and vocabulary learning

3.2.2 Refugees and language learning

There are currently more than 25 million refugees around the world [107]. Refugees typically go through three different stages of migration: (i) the premigration and departure stage, (ii) the transit stage that can include a long wait in a different country before the final relocation, and (iii) the resettlement stage during which refugees take residence in their final host country [30].

Among the various difficulties that refugees encounter during their journey, language presents a primary challenge. [18]. Refugees use different language learning methods depending on their location and the resources available to them. These methods usually include attending language classes and using dictionaries. Furthermore, a large number of refugees use smartphones with which they have access to mobile language learning tools [9, 39]. In this scheme, the development of mobile technologies for language learning can help refugees to learn a new language. Indeed, the EU highlighted the importance of such tools and supported their development through the EU Integration Action Plan of Third-Country Nationals.

Knowing the tacit and latent language learning needs of refugees can inform the design of features in a language learning tool that targets them. To our knowledge, there are no previous studies that explore the language learning needs of refugees, and no previous learning language tool has been created to support refugees in different stages of their journey.

Transition phase: Syrian refugees in Lebanon

Lebanon is the country with the highest number of refugees per capita; it has 5.5 million residents and hosts more than 1.5 million refugees. The majority of the refugees in Lebanon emigrated from Syria after the eruption of the Syrian Civil War in 2011.

Syrian refugees speak Arabic, the national language of Lebanon, and therefore don't need to learn a new language for social inclusion purposes. However, some young Syrian

refugees are trying to study English, [22, 92], which could help them immigrate to a third, safer country with better education opportunities and more respect for human rights [108]. Moreover, English literacy increases their chances of enrolling and succeeding in Lebanese schools where science and math classes are taught in English or French [85]. Young Syrian refugees who are studying English while in Lebanon are in a similar situation as other refugees in transition to a third country. They cannot benefit from the advantages of being surrounded by the language they aim to learn. Moreover, being in transition often involves living in harsh and unstable conditions that are not ideal for language learning.

Most of the refugees in Lebanon cannot attend English classes due to their special socio-economic circumstances, low government support, and a lack of educational infrastructure. However, approximately 86% of Syrian refugees in Lebanon own a smartphone and have access to the internet [104]. Hence, internet-enabled smartphones can provide refugees with the opportunity to learn languages through available online content and mobile applications [12].

It is important to note that existing language learning tools for refugees mainly support refugees who plan to reside in their host country long-term and aim to learn the local language for social inclusion purposes [5, 82]. Different considerations and tools are needed to support Syrian refugees in Lebanon, and refugees in similar life situations.

Settlement phase: Syrian refugees in Germany

Germany has hosted approximately 720,000 Syrian refugees as of 2017 [19]. Refugees in Germany are required to attend compulsory integration and language classes. Moreover, applicants must prove proficiency in German when applying for permanent residency . Additionally, refugees must obtain a German language certification if they wish to work or attend university.

Syrian refugees studying German in Germany are in a similar situation as other refugees who are settling in a new country. . They are learning the national language of their host country and struggling to build a new life in a new society [30].

Previous studies have explored the role of technologies in refugees' language learning and integration processes [5]. The gaps in current language learning tools were investigated by analyzing how migrants appropriate existent language learning tools while in their settlement phase. Migrants' experiences indicated a need for additional social, meta-cognitive, and emotional support [35]. Moreover, language learning applications have been

created specifically to help refugees learn a new language. *Moin*, for example, is a language learning application targeting refugees in Germany. It both enables and motivates local and migrant teenagers to meet for social events to practice German [82]. *Ankommen*, created by the German government, is another application that supports refugees with their arrival to Germany by connecting them with German-speaking volunteers. *Refugee Phrasebook Interactive 2* is an application that provides refugees with one thousand basic sentences that they can use in their everyday life. However, the existing studies and applications do not extract the language learning needs of refugees in Germany, from refugees themselves.

3.2.3 Understanding the users' needs through participatory design

Sanders [93] suggests accessing people's experiences by (i) listening to what they say and deducing explicit knowledge, (ii) watching what they do and deducing tacit needs, and (iii) seeing what they dream about and deducing latent needs.

Explicit knowledge is the knowledge that designers can extract from conventional study techniques such as interviews and observations.

Tacit needs are needs that people act upon but cannot express in words. Tacit needs can be deducted from observations and generative sessions [88]. Generative sessions are usually conducted in the early stages of the design process to identify the consumers' yet unknown needs. One way to identify those needs is by engaging the users in the design process and looking at the resulting user-generated artifacts [93].

Latent needs are needs that people are not yet aware of and that become realized in the future. Latent needs can also be deducted using generative sessions [110]. Another common way of identifying latent needs is through the identification of recurrent themes in the participants' verbal explanations [94].

Researchers have also used Participatory Design (PD) techniques to extract the tacit and latent needs of users [50, 51, 109]. PD is a set of practices and theories that aim to involve the end users of a technology in its design [76]. Rather than extract knowledge from participants, the objective of PD is to co-construct knowledge [109]. Through PD, designers are able to access the user's past, current, and potential experiences and provide a better design of the user's future experiences.

Spinuzzi [100] describes a detailed methodology to conduct PD workshops. The

methodology consists of three consecutive stages:

Stage 1: Initial exploration of the work. In this stage, the designers meet the participants and familiarize themselves with the way they work together. This stage also includes the exploration of technologies used by the participants and draws from ethnographic methods such as observations and interviews [100].

Stage 2: Discovery process. In the discovery process, various design thinking techniques are used to clarify the participants' needs and values. For example, *future workshops* could be organized where participants criticize the present, envision the future, and implement a solution [76, 100]. This stage usually involves heavy interaction between the designers and the participants and is important to understand the tacit and latent needs of the participants.

Stage 3: Prototyping. In this stage, participants and designers shape the technological artifact using a variety of prototyping techniques.

3.3 Methods

The aim of this work was to identify the tacit and latent language learning needs of Syrian refugees in Lebanon and Germany. We identified these needs through two PD workshops conducted in Lebanon and Germany over a period of two months. Each PD workshop included an introductory session and two PD sessions. Two of the authors of this paper were involved in the facilitation of the PD sessions. We chose to conduct PD workshops for four main reasons. First, the experience of refugees is difficult to access as outsiders and their participation and insight is essential to understanding their needs. PD allows access to people's experiences [93]. Second, there is no previous knowledge of the language learning needs of refugees in different stages of their journey, and PD provides a means to extract those needs. Third, we assumed that the participants might have needs they are unaware of, and through the ideation phase, PD reveals some of those needs [110]. Finally, we believe that the refugees should be active participants in the design process of tools that target them.

3.3.1   Recruitment and settings

Lebanon

We recruited Syrian refugees residing in the Chouf region of Lebanon. To help us with the recruitment process, we contacted their community leader, who supervises and manages informal tented settlements in Lebanon. The community leader usually acts as the settlement supervisor and decision maker. The participants were required to (i) have internet-enabled smartphones and (ii) be learning English at the time of the study. Although we also asked the community leader for an equal representation of genders, he was able to recruit five men and only three women between the ages of 14 and 25. He explained that most of the women he contacted already had children and housekeeping duties, and had no interest in learning a new language. Moreover, the three recruited women did not own a smartphone but had limited access to the smartphones of their brother, father, or husband.

We met with the participants after 5 pm as most of them had work during the day. The meetings and the PD workshops took place in outdoor settings in a village in the Chouf region of Lebanon. The workshop settings are shown in Figure 3.1.

Germany

Ten Syrian refugees were recruited through the ReDI School of Digital Integration, a non-profit organization based in Berlin that offers refugees technology-related training. The participants were between 26 and 54 years old. All the participants owned internet-enabled smartphones and were learning German at the time of the study. Although we tried to recruit an equal number of women and men, we were able to recruit seven men and only three women. Our contact explained that most of the female refugees didn't have time to join the workshops as they had to take care of their children and do housework. We used ReDI school facilities to hold the interviews and the PD workshops.

Due to the smaller number of women in the group and the possible risk of the women being less vocal in a majority male group, we separated the men and women into two different groups and conducted the workshops separately. By doing so, we aimed to provide the women with more space to express their unique personal thoughts and experiences.

We met the participants in the late afternoon as most of them were attending German classes during the day. The workshop settings are shown in Figure 3.2.

Figure 3.1: Settings of the participatory design workshop with the Syrian refugees in Lebanon

Ethical considerations

Prior to the start of both workshops, we explained the aim of the study to the participants and informed them that the results might be published. All the participants gave their consent to participate in the study. A parent of each minor participant gave consent for their child to participate in the workshop. The participants were informed that their names and usernames would be altered to preserve their anonymity. Moreover, we informed the participants that they could withdraw from the study at any point.

Participatory design workshop

We conducted the PD sessions following the methodology described by Spinuzzi [100].

Stage 1: Initial exploration of the work. First, we met the eight participants and introduced the design challenge as: "What tools would improve your language learning?"

Figure 3.2: Settings of the participatory design workshop with the Syrian refugees in Germany

Then, we conducted individual interviews with the participants to collect the following information: their age, occupation, mode of accessing the internet, motivations for learning English, and the methods they use to learn English. The interviews were conducted in Arabic. All the interviews were recorded, translated from Arabic to English, and transcribed.

Finally, we introduced a free language learning website to the participants and asked them to use it for a period of ten days. The goals of this assignment were to understand the extent of their familiarity with technologies and give them the opportunity to reflect in preparation for the future PD sessions.

Stage 2: Discovery process. The session took the form of a future workshop. Future workshops are a commonly used workshop format used in PD. Future workshops proceed in three consecutive stages: (i) criticizing the present, (ii) envisioning the future, and (iii)

implementing[76].

Our session was conducted as follows:

Criticizing the present. In this stage, we started by introducing the participants to the concept of brainstorming. Then, we asked them to brainstorm on the difficulties they encounter while learning English or German. We asked the participants to write down each difficulty on a separate sticky note. After the brainstorming session, the participants shared their input with each other to gain a shared understanding of the problems they face. Finally, the participants grouped the similar difficulties together and chose three difficulties they would like to focus on.

Envisioning the future [93]. In this stage, we asked the participants to imagine the lexicon they would like to learn in the target language and how they would like to learn it, if all possibilities were open to them. The session was organized as follows: First, we conducted a second brainstorming session where the participants wrote down the different lexicon they would like to learn (e.g.: lexicon to find a job, lexicon to buy food in the supermarket). Each type of lexicon was written down on a separate sticky note. Following the brainstorming session, the participants shared their input with the other group members to gain a shared understanding of their aspirations. The participants were also asked to group similar lexicons together. Next, we asked the participants to brainstorm ideas for language learning tools that would help them learn English. We asked participants to come up with as many ideas as possible without worrying about the originality or feasibility of their ideas. The participants grouped the ideas into different categories and mapped them to the different difficulties and lexicons produced previously. Finally, the participants chose three ideas and combined them into one idea that they would later prototype.

Stage 3: Prototyping. In this stage, we asked the participants to paper prototype their final idea using cardboard, pens, and colored markers.

Identifying the tacit and latent needs

The tacit and latent needs of the refugees were identified using a thematic analysis approach. One of the authors conducted the analysis. The results of the analysis were reviewed and confirmed by another author. First, we transcribed the content of the PD sessions. The transcribed data was composed of: (i) the sticky notes the participants

produced during the brainstorming session, (ii) the explanations that they gave when presenting their ideas, and (iii) the explanations that they gave when presenting the final prototype.

The thematic analysis was conducted separately for the two sessions *criticizing the present* and *envisioning the future*. The results obtained from the thematic analysis of the session *criticizing the present* correspond to the refugees' tacit needs. The results obtained from the thematic analysis of the session *envisioning the future* correspond to the refugees' latent needs.

For each session, we conducted the thematic analysis following the six-phase guide of Braun & Clarke [17]:

1. *Familiarization with the data.* As we collected the data through interactive means, we had a prior knowledge of the data along with some initial thoughts on it. Despite this, we went through the data again for a deeper familiarization with it.

2. *Coding the data.* While reading the collected information, we generated a list of codes and associated them with small chunks of the appropriate data.

3. *Searching for themes.* We refocused the analysis on broader level themes by combining several codes together.

4. Reviewing themes. In this phase, we refined the chosen themes by eliminating some that had too little data associated with them and merging others to form new themes.

5. Defining and naming the themes. At this stage, we identified the essence of the themes and translated it in terms of needs.

6. Producing the report. The resulting needs were described (see result section).

3.4   Results

We report our findings in three sections. The explicit knowledge section describes the participants' motivations to learn a new language, the methods they use to learn the new language, and their familiarity with mobile technologies. The tacit needs section presents the unarticulated needs of Syrian refugees regarding language learning. Finally, the latent needs section presents the needs regarding language learning that Syrian refugees have

and are not yet aware of. For each of the sections, we report the results that are common to the refugees in Lebanon and Germany and the results that are specific to each of the two groups.

3.4.1 Explicit knowledge

Explicit knowledge was extracted from the individual interviews with the participants and our observations of their familiarity with mobile technologies.

Motivations to learn the target language

Syrian refugees in Lebanon.   In the interviews, the participants reported three main reasons for learning English, which appear to be directly linked to their occupations. In fact, the participants who were enrolled in Lebanese schools wanted to learn English to understand the science and math classes and succeed at school. One female participant, a mother whose children attend Lebanese schools, wanted to learn English to help her children succeed at school. Even though it is essential for Syrian refugees to learn English for educational purposes, they reported that their end goal is to leave Lebanon. The participants who were single and employed reported that they want to learn English to facilitate their exit from Lebanon. Two young male refugees reported that they will not return to Syria because they escaped the compulsory military service there, but they cannot foresee a future for themselves in Lebanon. Another male refugee wanted to leave Lebanon for Canada, where his wife resides. As she was underage when they got married, she did not report her marriage upon arrival to Canada, and therefore cannot help him get a spouse visa. Her husband is now trying to immigrate there; he explained, "Learning English will give me more points and facilitate the approval of my application."

Syrian refugees in Germany.   During the interview phase, participants expressed their desire to learn German to be able to settle in Germany. Six participants reported that learning German will allow them to enroll at university or find full-time employment. One noted, "We need a certificate of language to enroll at university or to find any kind of job." Three participants who are currently enrolled in a German university reported that learning German is essential to stay in Germany, be part of the society, and "maybe try to become a German citizen." One female participant stated that she came to Germany to be close to her children who were already there. Learning German will allow her to

stay close to them; she said, "I am not in this situation by my own will, I was forced into it. The kids left Syria and I cannot live without them. I want to learn German to be able to work here and stay close to them." Learning German is a way for all the participants to build a life in Germany and the reported motivations were common to the participants regardless of gender, age and occupation.

Methods of learning the target language

Syrian refugees in Lebanon. The methods for learning English depended on the occupation of the participants and their gender. The participants who were enrolled in Lebanese schools learn English at school. A 23-year-old male participant uses Duolinguo, a mobile application, to learn English. The rest of the participants rarely attend English sessions provided by NGOs. A female participant reported using dictionaries to learn English. As mentioned earlier, female participants did not own smartphones and used smartphones belonging to their brothers, husbands, or fathers to connect to the internet. This restricts their connectivity time and limits their possibilities of using mobile technologies for language learning.

Syrian refugees in Germany. All participants reported learning German through the free German classes offered by the German government. The participants were attending classes ranging in level from A1 to C1 (A1 being the most basic level and C1 the second most advanced level). Moreover, male participants reported using language learning applications to improve their language skills, whereas female participants were learning mainly through the language classes. The Language applications used by men included *Google translate*, *Flashcards*, *Rosetta Stone* and *Arabdict*, a crowdsourcing Arabic-German dictionary.

Familiarity with mobile technologies

Syrian refugees in Lebanon. We asked the participants to sign up for and use a language learning website in order to understand the extent of their familiarity with technologies. The participants were required to input an email address, create an account on the website and learn a couple of words. Most of the participants had email addresses but could not remember them. The facilitators helped retrieve them by looking at other applications on their phones. Most of the participants were familiar with the Arabic

keyboard. Two participants had difficulties typing in Arabic due to their low literacy level. The participants were very slow while using the English keyboard as they took time to search for each letter.

Syrian refugees in Germany. We followed the same process in Germany, asking the participants to sign up for and use a language learning website in order to assess their familiarity with technologies. Nine of the participants were very familiar with the process and easily performed the tasks using the English and Arabic Keyboard. However, the men showed more familiarity with the English keyboard compared with the women. The oldest participant, a 54- year-old woman, took more time to complete tasks using the website compared to the other participants. She also had difficulties with the signing up process and the English keyboard and needed assistance from the facilitator.

A summary of the explicit knowledge collected through the interviews in the exploration phase is presented in Table 3.1 and Table 3.2.

Table 3.1: How and why are the participants learning English in Lebanon

Participant	Gender	Age	Occupation	Learning method	Motivation	Internet access method	Familiarity with mobile technology
P1	Female	16	N/A	English sessions	Study in Canada	Father's phone	Unfamilar
P2	Female	14	Student	At school	Succeed at school	Father's phone	Unfamilar
P3	Male	15	Student	At school	Succeed at school	Own phone	Familar
P4	Male	23	Plumber	Duolingo	Move to Canada	Own phone	Familar
P5	Male	15	Mechanic	English sessions	Leave Lebanon	Own phone	Familar
P6	Male	18	Mechanic	English sessions	Leave Lebanon	Own phone	Familar
P7	Female	25	N/A	Dictionnary	Help her children	Husband's phone	Unfamilar
P8	Male	18	Student	At school	Succeed at school	Own phone	Unfamilar

Table 3.2: How and why are the participants learning German in Germany

Participant	Gender	Age	Occupation	Learning method	Motivation	Internet access method	Familiarity with mobile technology
P1	Female	54	N/A	German school	Find employment	Own phone	Unfamiliar
P2	Female	29	N/A	German school	Enroll at university	Own phone	Familiar
P3	Female	26	N/A	German school	Enroll at university	Own phone	Familiar
P4	Male	26	Student	Applications	Stay in Germany	Own phone	Familiar
P5	Male	31	Student	Applications	Stay in Germany	Own phone	Familiar
P6	Male	30	Student	Applications	Get naturalized	Own phone	Familiar
P7	Male	39	N/A	German school	Find employment	Own phone	Familiar
P8	Male	35	N/A	German school	Find employment	Own phone	Familiar
P9	Male	29	N/A	German school	Find employment	Own phone	Familiar
P10	Male	39	N/A	German school	Find employment	Own phone	Familiar

3.4.2 Tacit needs

We present below the tacit needs that we identified through the thematic analysis.

Common needs of Syrian refugees in Lebanon and Germany

Need for time management. During the brainstorming session, the participants in Lebanon reported lacking time to study English. The participants who were employed work all week and do not benefit from any days off. Some of the students go to school for half a day and work for the other half. Moreover, participants reported being tired in the evenings when they finally had the opportunity to study English.

The participants in Germany reported a lack of time to review the German lessons

learned during the day. Due to their unstable housing situation, appointments with government officials, and long amounts of time spent on Berlin's public transport system, participants have little time left to study German. Moreover, female participants reported that their housekeeping and child-rearing duties were time consuming: "I wish the German government provided housekeeping training courses for Syrian men."

Need for recollection. While brainstorming the difficulties of learning English, the participants expressed their tacit need for recollection. Participants in Lebanon reported their inability to remember the vocabulary they learn. In the discussion that followed, the participants expressed their discouragement, e.g., "I forget a lot. I learn a word, then I forget it."

The participants in Germany reported that they often forget uncommon words that they learn as they don't have the opportunity to use or hear them.

Need for social learning. The participants in Lebanon reported feeling lonely when learning English. Few people around them are interested in learning a new language or are supportive of their endeavor.

The participants in Germany expressed the need for social learning with Germans, in contrast to the refugees in Lebanon who wished they could learn with their compatriots. Participants in Germany reported a desire for more contact and exchange with Germans. The tacit need for social learning was expressed in the brainstorming session as well as in the following discussions.

Tacit needs of Syrian refugees in Lebanon

Need for discipline. The tacit need for discipline was extensively expressed by the participants. On multiple occasions throughout the workshop, the participants complained about their lack of commitment to learning English. Moreover, three participants wished there was a teacher who was willing to teach them English because then they "will have to attend."

Need for motivation. The participants reported that they often see themselves losing their motivation to study English. "It is hard to find a job if you are Syrian in Lebanon, and it is hard to leave Lebanon. Sometimes, I just don't feel like learning anymore."

Need for calm.   Participants reported living in very noisy environments that do not support tasks that require concentration. Moreover, they reported being continuously distracted by members of the family or members of the community as it is common for a large number of people to live in the same house.

Tacit needs of Syrian refugees in Germany

Need for contextual vocabulary teaching.   The participants expressed the need for specific vocabulary knowledge. Polysemous words in the German language are problematic: "Words have different meanings, I don't know how to use them." Moreover, participants stated difficulties understanding and using bureaucratic vocabulary or field-specific terms.

Need for identity appreciation.   Participants extensively expressed the tacit need for the appreciation of their identity: "We have an old culture and civilization, this is what I would like to share." "People ask me if you we have cars in Syria, of course we have cars in Syria. I don't have the vocabulary to explain what Syria is."

3.4.3   Latent needs

We present below the latent needs identified from the thematic analysis.

Common latent needs of Syrian refugees in Lebanon and Germany

Need for self-expression.   When envisioning the future, the participants reported a latent need for self-expression. All participants in Lebanon expressed their desire to learn how to introduce themselves and communicate with people. Moreover, their ideal language learning tool would allow them to go to the market and "sell" things. Participants wished they could be able to present themselves well in work or visa interviews. A participant shared his desire to learn "big words" to express himself better.

In Germany, participants wished they had the skills to speak about philosophy or social issues with Germans: "I am not able to express my deep thoughts or to conduct interesting discussions."

Need for fun.   When describing ideal language learning tools, the participants in Lebanon and Germany expressed the desire for "a fun application" or "an entertaining tool."

The participants in Germany imagined an application that would allow them to watch movies based on their vocabulary knowledge: "The content we find is usually either boring or very difficult to understand."

Latent needs of Syrian refugees in Lebanon

Need for foreigners.   During the ideation session, participants expressed a latent need to meet and interact with non-Arab foreigners. Refugees in Lebanon often come directly from Syria and have few opportunities to meet non-Arab foreigners. Many application ideas involved a "foreign teacher," "seeing foreigners," "talking with foreigners," and "traveling and meeting foreigners." Interaction with foreigners was a recurrent topic in the participants' discourse.

Need for the presence of English.   Through the ideation session, participants showed a latent need for the presence of English. When imagining the future, participants imagined a world where they will be surrounded by English: "I would like to see ads in English on billboards, with an Arabic translation," "I would like to have all the names of things in the supermarket in English."

Latent needs of Syrian refugees in Germany

Need for German friends.   Participants repeatedly expressed their need for a close relationship with a German person. During the ideation session, participants imagined a solution that would allow them to have German friends. The female participants who were wearing veils expressed this need more strongly. They reported feeling a reluctance from Germans to have social interactions with them: "I think it is much easier for men and non-hijabi women to learn German and interact with Germans."

Need for feeling equal.   The need for equality was expressed in different forms. Some participants reported that they prefer speaking English with Germans, as it puts them on equal ground: "They are not speaking their native language, I am not speaking mine, the interaction is more equal." Moreover, some participants expressed the desire to volunteer "as a way to give something to German society:" "We are in an inferior position, Germans need to be patient when we speak German slowly. I would like to contribute in some way." Finally, during the ideation session, participants proposed the creation of an Arab-

German channel where German movies are translated to Arabic and vice-versa: "They will learn about our culture, and will learn more about theirs."

A summary of the tacit and latent language learning needs of the refugees is presented in Table 3.3.

Table 3.3: Tacit and latent language learning needs for Syrian refugees in Lebanon and Germany

Category	Need
Common tacit needs	Need for time management Need for recollection Need for social learning
Tacit needs of Syrian refugees in Lebanon	Need for discipline Need for motivation Need for calm
Tacit needs of Syrian refugees in Germany	Need for contextual vocabulary learning Need for identity appreciation
Common latent needs	Need for self-expression Need for fun
Latent needs of Syrian refugees in Lebanon	Need for foreigners Need for the presence of English
Latent needs of Syrian refugees in Germany	Need for German friends Need for feeling equal

3.5   Discussion

We conducted PD workshops with Syrian refugees in Lebanon and Germany and identified their tacit and latent language learning needs. In addition, we presented the Syrian refugees' motivations to learn a new language, the learning methods they use, and their familiarity with mobile technologies through interviews and observations.

It has been noted that the tacit and latent needs are derived from a rather small number of refugees. Despite the obvious limitations, the results are relevant for two main reasons. First, to our knowledge, no previous study has aimed to understand the needs of

refugees throughout the different stages of their journey, even though those populations require special attention and support. Second, our study retrieved the tacit and latent needs of refugees through PD sessions. Therefore, the results deepen the understanding of (i) what refugees say, (ii) what they need and don't express in words, and (iii) what they will need in the future in the context of language technologies.

In the following sections, we discuss our findings and the opportunities for designing language learning tools that support refugees' language learning processes.

General language learning needs of refugees. All learners have common needs and many of them have been explored extensively. The need for fun has been explored as a way to learn more effectively [86] and is not unique to refugees. Additionally, our findings show the need for social learning that could be associated with the benefits of learning within a community of practice [64]. However, some of the needs that we found are stronger in refugee communities and others are specific to them. Previous studies confirm that the need for socio-collaborative learning is strongly present in refugee communities [35]. Moreover, our results confirmed the need for language learning tools specifically targeting refugees and answering their unique needs. In fact, the tacit needs for recollection and calm are more likely to be present within refugee communities. The need for recollection was highly present in the discourse of the refugees in Lebanon and Germany and could be caused by memory impairment. Previous studies on refugees showed that PTSD, depression, and general distress could lead to memory impairment [53]. Moreover, the tacit need for calm is confirmed by a previous study stating that noise in the camp is one of the most frequent problems reported by refugees [14]. The refugees in Lebanon and Germany expressed the needs for time management and identity appreciation. These two needs are directly related to the difficulties of settling in a new country and being a refugee.

Different language learning needs of refugees in Lebanon and Germany. Some of the tacit and latent needs identified in this work confirmed the difference of language learning needs between the Syrian refugees in Lebanon and Germany.

The latent need for foreigners is particular to the Syrian refugees in Lebanon. Syrian refugees in Lebanon often come directly from Syria and have few opportunities to meet non-Arab foreigners. Meeting or having contact with foreigners would allow them to

put into practice what they have learned, thereby boosting their confidence and enabling them to communicate with the external world. The refugees in Lebanon also expressed a latent need for a greater presence of English in their environment. Refugees learning the language of their host country encounter their target language continuously throughout their daily life. However, Syrian refugees in Lebanon expressed a desire for a more concrete application of their newly learned skills and more opportunities to be exposed to the language.

On the other hand, Syrian refugees in Germany expressed the need for identity appreciation, a need that has been shown to create stress among refugees as an impact of acculturation [15]. The need for a German friend, or a friend from the host culture, is another need that is specific to refugees in the settlement phase.

Interestingly, some Syrian refugees in Germany reported choosing to speak English, not German, in an attempt to be on equal ground with German citizens. This purposeful avoidance of speaking German negatively affects their chances of practicing the target language.

The refugees in Lebanon expressed a need for motivation whereas the refugees in Germany did not. This could be due to the different nature of their goals. For Syrian refugees in Lebanon, learning English could help them, but is not mandatory nor does it guarantee that they will achieve their goals. Getting their visa applications approved or succeeding in Lebanese schools relies on many other factors. Conversely, learning German is mandatory for Syrian refugees to achieve their goal of long-term settlement in Germany. Moreover, the effect of learning German is concrete and palpable in their everyday interactions.

Implications for the design of language learning tools. The previously presented needs provide multiple opportunities for designing language learning tools to support refugees in their language learning activities. These features could be included in language learning tools for Syrian refugees in Lebanon and Germany, or refugees in similar situations.

To answer the need for time management and discipline, refugees can be provided with data that recommends the best times and locations for studying based on their past learning activities. Data on log in study times have already been collected in existing language learning tools, as well as location data in some cases. These data points could

be analyzed to provide such recommendations.

To answer the need for recollection, language learning tools could measure the retention rate of the refugees by providing flashcard type quizzes. The data that is collected from the quizzes could be analyzed later to adapt a spaced repetition system based on the individual recollection needs of the refugees.

The need for motivation could be answered by analyzing the refugees' performance on the language learning tool and providing them with the opportunity to share their advancement reports with embassies or schools. By doing so, the language learning tools would provide them with a concrete and palpable outcome that they could use to achieve their goals.

The need for calm could be answered by encouraging the refugees to study when a calm environment is detected. The noises surrounding the learner could be detected through the phone's microphone.

Refugees reported the need for contextual vocabulary learning. To meet this need, dictionary and location data could be collected and analyzed to understand the lexicon that the refugees are potentially interested in learning in specific contexts. Based on this analysis, the language learning tool could provide the refugees with new words to learn, or previously learned word to recollect, in those contexts. Moreover, the latent need for the presence of English, expressed by Syrian refugees in Lebanon, could be answered through lifelogging ubiquitous language learning features that recommend objects to learn depending on the location of the learner. Ubiquitous language learning environments have shown to be beneficial for language learning in that they help the language become embedded in the daily life of the learner [83]. Learners should be able to upload logs offline. The synchronization of the logs and the recommendation system could be activated when an internet connection is available.

The refugees reported that the needs for identity appreciation and self-expression are affecting their learning. To answer these needs, language learning tools can collect information on the work, educational background, and interests of the refugees. Based on this information, the tool could provide them with language learning materials that allow them to talk about their Syrian identity, themselves, and their interests. Furthermore, by collecting feedback on the learning material, the tool can recommend new learning material based on what other refugees with similar backgrounds found useful.

The needs for social learning, foreigners, German friends, and a feeling of equality were

extensively reported by the refugees throughout the discussions. However, those needs, social in their nature, can hardly be met through traditional language learning tools. We encourage researchers and designers to further investigate ways to address these challenges through language tools that support refugees in their learning activities.

3.6 Conclusion

Through Participatory Design workshops, this work identified the tacit and latent language learning needs of Syrian refugees in Lebanon and Germany. The Syrian refugees in Lebanon and Germany appeared to have both overlapping and distinct tacit and latent needs. The tacit needs for time management, recollection, and social learning were common to the participants in Lebanon and Germany. Participants in Lebanon expressed the tacit needs for discipline and calm whereas participants in Germany communicated the tacit needs for contextual learning and identity appreciation. Moreover, the latent needs for self-expression and fun were common to the two refugee groups. The latent needs for foreigners and the presence of English were expressed by the Syrian refugees in Lebanon whereas the Syrian refugees in Germany communicated the latent needs for German friends and a feeling of equality. Based on these results, we discussed the opportunities and challenges for designing language learning tools to support the language learning activities of refugees.

Chapter 4

Vocabulary selection: Need-based vocabulary recommendation using the informal learning activity

4.1 Introduction

Vocabulary selection in an informal learning environment

Language learners want to learn words that correspond to their needs and the goals that they value [74]. This strategy is efficient as learning useful words allow people to use and practice the language, which leads to an increase in their vocabulary [78]. Consequently, learning the vocabulary that one needs is important to improve the vocabulary knowledge. However, learners might have difficulties knowing which words are useful to them and will be encountered in their daily lives. Most curriculum are not adapted to the particular needs of individual learners. In fact, the most frequent words are selected based on the most common vocabulary used by native speakers. However, language learners often have different vocabulary needs that do not necessarily match the natives speakers' needs. For example, the word 'fridge' is one of the most commonly used words by native speakers, as it is often used within a household. On the other hand, a foreign language learner, even one immigrating to a foreign country, would rarely need the word 'fridge', as they would probably be living alone or in a household where the target language is not spoken.

Today's widespread usage of information technologies for language learning offers an opportunity to collect the vocabulary needed by a particular group of learners and provide a need-based vocabulary recommendation. This work aims to help language learners select the vocabulary that they need based on their past learning activity in an informal learning

environment.

Case study: refugees population

Similarly to Chapter 2, we chose the refugees population as a case study. In fact, refugees have a strong need to learn a language [18] throughout their migration journey. Depending on the migration stage in which they are in, refugees have different vocabulary learning needs [3]. Aligning with the need for refugee-specific language learning tools, major calls were made for the creation of functional curriculum for refugees [27, 60]. Even though these calls started in the 1980s, most of the currently used curriculum are still not adapted to the learning needs of refugees. Moreover, when language learning applications, or materials, provide vocabulary targeting refugees, they regard the refugees as one uniform group. Furthermore, the curriculum usually reflects the values and attitudes of curriculum writers rather than the specific needs of the refugees [106]. These limitations could be attributed to the difficulty in identifying the specific vocabulary that a refugee needs to learn in their particular migration stage.

Nowadays, the widespread usage of smartphones within the refugee population [39] provides us with new opportunities to adapt the curriculum according to their needs. When using informal mobile learning environments, the refugees' past learning data is stored in their learning history logs. By tapping into their previous learning data, we can identify the specific vocabulary that a refugee needs to learn. Eventually, we could create a curriculum that teaches the refugees the vocabulary that they need to learn based on their individual migration stage.

4.1.1 Goals of the study

In this work, we propose using the past learning history of refugees to recommend them new vocabulary to learn. To do so, we collect the past learning history of 25 Syrian refugees in transition in Lebanon and 12 Syrian refugees settling in Germany. The past learning history is collected from the database of an informal mobile learning environment used by the participants. Once the past vocabulary is collected, we categorize it by themes. Afterwards, we identify the topmost populated categories for Lebanon and Germany separately. Finally, we recommend to the participants new vocabulary consisting of words that belong to the top categories. To assess the efficacy of our method, we compare the motivation levels and learning achievement of the participants when learn-

ing the vocabulary recommended by our method in comparison to learning their textbook vocabulary.

To these ends, this study carried out an experiment to answer the following research questions:

1. What is the vocabulary needed by Syrian refugees in Lebanon and Germany?

2. Does recommending vocabulary based on the refugees' past learning history improve their learning achievement when learning the new vocabulary?

3. Does recommending vocabulary based on the refugees' past learning history increase their motivation levels for learning the new vocabulary?

4.2 Methods

This work aims to extract and recommend, using an informal learning environment, the vocabulary needed by refugees in different stages of their journey. To do so, we propose to select as a first step the learning logs input in an informal learning environment by the refugees in the same migration stage. We then group the vocabulary by category and extract from a vocabulary database further vocabulary belonging to the top categories. The extracted vocabulary would be recommended to learners. The flow of the method is shown in Figure 4.1. In this section, we show how we applied the method to extract and recommend the vocabulary needed by Syrian refugees in transition in Lebanon, and settlement in Germany.

4.2.1 Participants

25 Syrian refugees residing in Lebanon, and 12 Syrian refugees residing in Germany were selected to participate in this study for the experiment. The participants in Lebanon were recruited through the community leader, social media and word of mouth. The participants' ages ranged between 18 and 53. All participants were learning English at the time of the study and were planning to move to another country. On the other hand, the participants in Germany were recruited through an NGO, ReDI School of Digital Integration, as well as calls for participation through social media and word of mouth. The participants in Germany were aged 18 and 67 years old. The participants in Germany were learning German and were hoping to settle in Germany. The selection
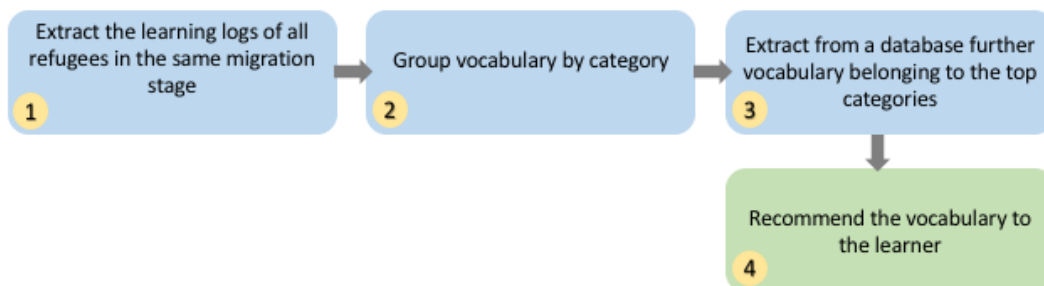
Figure 4.1: Flow of the method

criteria required the participants in Lebanon and Germany to (i) have daily access to a smartphone, (ii) be learning a target language, and (iii) have an elementary level in the target language.

Prior to the start of the study, we explained to the participants in Lebanon and Germany the aim of the study and informed them about the potential publication of its results. All the participants gave their consent to participate in the study. The participants were informed that their names and usernames will be altered to preserve their anonymity. Moreover, we informed the participants of the possibility to withdraw from the study at any point.

4.2.2 Collection of the needed vocabulary

To extract the vocabulary needed by the Syrian refuges in Lebanon and Germany, we asked the participants to log into SCROLL, the informal learning environment, the vo-

cabulary they need on a daily basis, during a period of ten days. Moreover, we asked the participants to report in the description of the context in which the vocabulary was needed.

4.2.3 Categorization of the vocabulary

Once the vocabulary collected from the participants in Lebanon and Germany, it was translated into English based on the context of use reported by the participants. We then separated the vocabulary into two sets, the words logged by participants in Lebanon and the words logged by participants in Germany. For each set, we categorized the vocabulary following the Cambridge English List categories. However, we could not fit all the logged vocabulary into existing categories of the Cambridge English List because a number of sensitive topics are considered unsuitable for use, e.g.: war and politics. Based on the vocabulary logged by the participants, we added three additional categories: society, spirituality, and bureaucracy. When the logged word could belong to many possible categories, we referred to the context of use reported by the participant, to assign the vocabulary to its corresponding category.

4.2.4 Vocabulary recommendation

At this point, we have a categorization of the vocabulary logged by the participants in Lebanon and Germany. For each of the sets, we select the most populated categories that comprise more than 80% of the logged words. For each of the participants' groups, we recommend vocabulary that belongs to their most populated categories in the vocabulary database and does not belong to their logged words. For the participants in Lebanon, the vocabulary database is the Cambridge English List for the A1 and A2 as they are learning English at an elementary level. Similarly, for the participants in Germany, the vocabulary database of the Goethe-Zertifikat for the A1 and A2 levels for as they are learning German at an elementary level.

4.2.5 Experimental procedure

The participants in the experiment were two groups of refugees. Group 1 comprised 25 Syrian refugees in transition in Lebanon, whereas group 2 included 12 Syrian refugees settling in Germany. Figure 4.2. shows the experimental procedures of the study. Both

groups learned a list of recommended words (List A), as well as a list derived from their assigned textbook (List B). Each of the list featured 15 words in Arabic translated into the target language. The learning achievement after learning the vocabulary presented in both lists was tested and compared. Moreover, the motivation of the participants to learn each of the lists was compared as well. To avoid our results being affected by the primacy effect, each of the groups was divided in two, with a part learning list A first, and the second part learning list B first. The learning achievement and motivation were tested after the participants learned each of the lists.
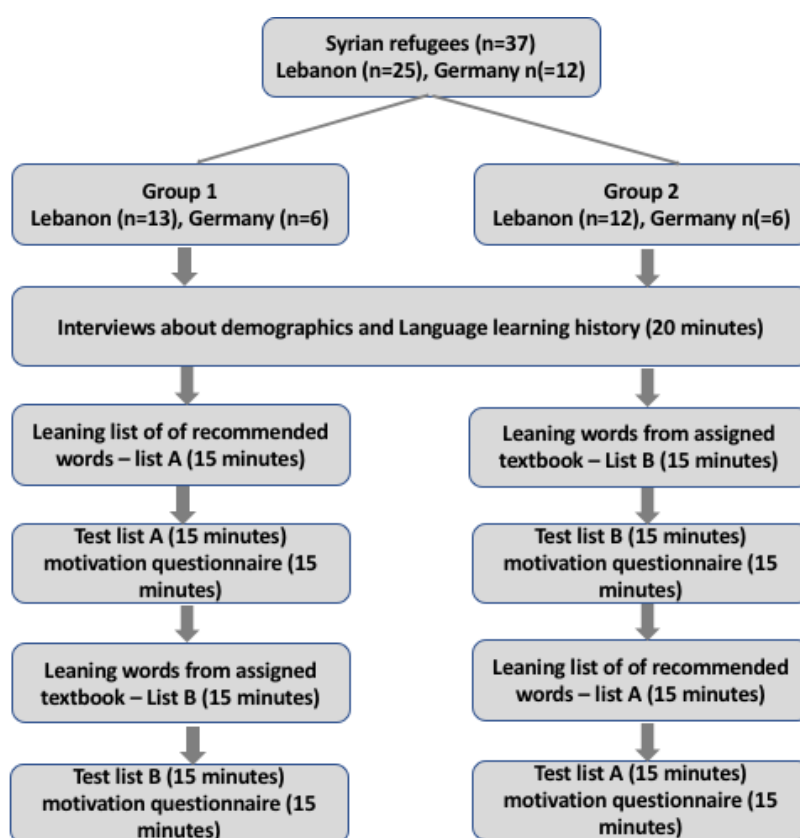
Figure 4.2: Experimental procedure

4.2.6 Measurement tools

This study employed two tests and a questionnaire concerning students' learning motivation as the measurement tools. The tests were vocabulary quizzes designed to test the participants' learning achievement after learning the recommended vocabulary (list

A), and the textbook vocabulary (list B). List A included randomly selected words from the recommended vocabulary. On the other hand, list B was extracted randomly from the elementary levels of the Cambridge English List and Gather-Zertificat for the participants in Lebanon and Germany respectively due to the different target languages of the participants. The questionnaire measuring the participants motivation was adapted and translated to Arabic from the measures developed by Hwang and Chang [48]. It consisted of seven items (e.g., "I think learning this vocabulary is interesting and valuable") with a five-point Likert scheme as shown in table 4.1. The Cronbach's alpha value of the questionnaire was 0.80, implying that the questionnaire is reliable.

Table 4.1: Motivation questionnaire

Item 1	I think those words are interesting and important
Item 2	I would like to learn more of those words
Item 3	It is necessary to learn those words
Item 4	I think it is important for me to learn those words
Item 5	It is important for me to know those words
Item 6	I will actively search for more words similar to those words
Item 7	It is important for everyone to learn those words

4.3   Results

4.3.1   Analysis of the needed vocabulary by Syrian refugees in Lebanon and Germany

The vocabulary collected by the Syrian refugees in Lebanon and Germany was categorized as shown in figure 4.3. The participants in Lebanon logged 1180 words whereas the participants in Germany logged 869 words. Some categories where common to the refugees in Lebanon and Germany such as: Food and drink, personal feelings, house and home, travel and transport, bureaucracy, communication and technology, clothes and accessories, society, shopping, work and jobs, time, education, the natural world, health and medicine and spirituality. The categories colors, weather ,and entertainment and media were specific to the refugees in Lebanon. Even though most of the categories were similar to the two groups, the distribution of the vocabulary varied from one group to the other. In fact, the most populated categories for Lebanon are, by order of words: food and drink, travel and transport, the natural world, health and medicine, house and home, education, personal feelings, and work and jobs. Those categories included more

than 80% of the total of words and were the basis of the vocabulary recommendation. Similarly, the most populated categories by the refugees in Germany are: food and drink, personal feelings, house and home, travel and transport, bureaucracy, communication and technology, clothes and accessories, society and shopping.
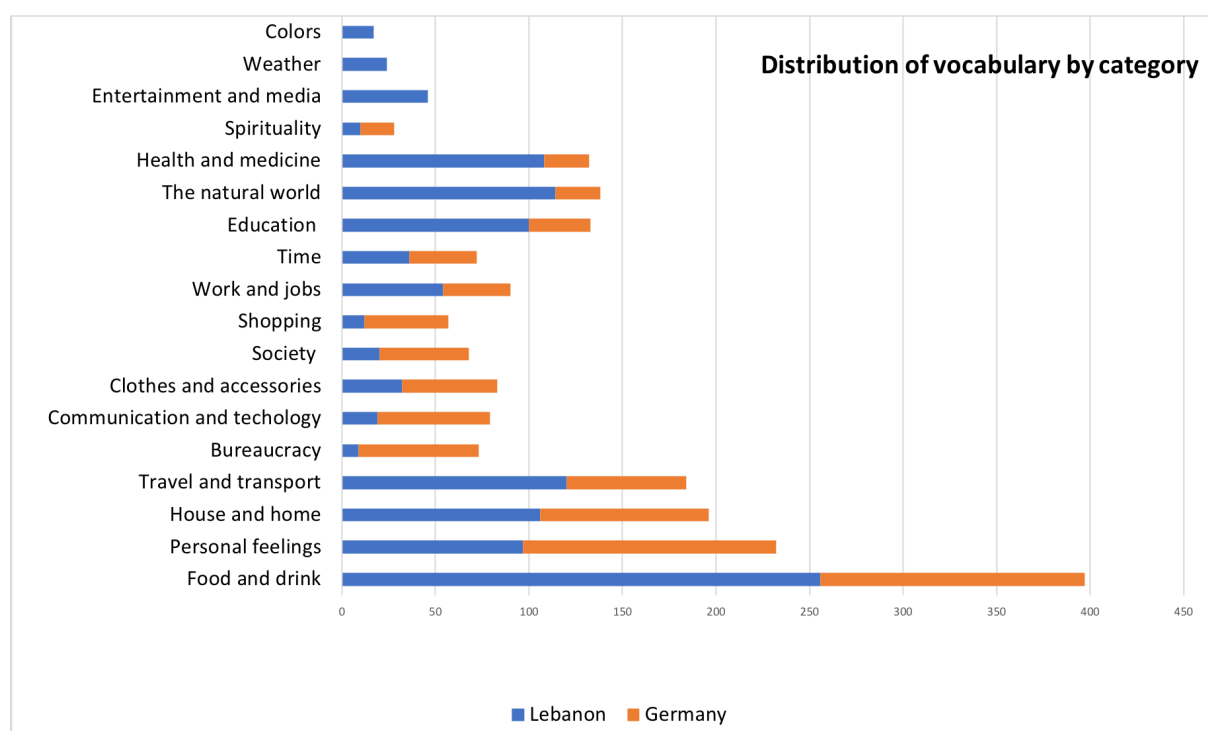
Figure 4.3: Vocabulary distribution in Lebanon and Germany

4.3.2 Analysis of the effect of the learning the recommended vocabulary

A t-test was used to analyze the differences in learning achievement and motivation after learning the recommended vocabulary and learning the textbook vocabulary.

Analysis of the learning achievements

Table 4.2. shows the results of the learning achievement for the Syrian refugees in Lebanon according to the tests of the vocabulary recommendation and the textbook vocabulary. The means and standard error were 78.40 and 18.79 for the textbook vocabulary, and 78.40 and 22.38 for the vocabulary recommendation. It was found that the tests scores for the two learning materials were not significantly different.

Table 4.2: Learning achievement in Lebanon

Method	N	Mean	SD	SE	t	df
Textbook Vocabulary	25	78.40	18.79	3.76	0.00	24.00
Vocabulary recommendation	25	78.40	22.38	4.48		

Table 4.3. shows the results of the learning achievement for the Syrian refugees in Germany according to the tests for the vocabulary recommendation and the textbook vocabulary. The means and standard error were 50.56 and 28.91 for the textbook vocabulary, and 65.55 and 27.54 for the vocabulary recommendation (t=2.63,p<0.05). It was found that the test score for the vocabulary recommendation was significantly higher than the test score for the textbook vocabulary. This implies that the vocabulary recommendation benefited the Syrian refugees in Germany more than the textbook that they use to learn German.

Table 4.3: Learning achievement in Germany

Method	N	Mean	SD	SE	t	df
Textbook Vocabulary	12	50.56	28.91	8.36	2.63*	11.00
Vocabulary recommendation	12	65.55	27.54	7.95		

*$p < 0.05$

Analysis of the learning motivation

Table 4.4. shows the results of the motivation for the Lebanon refugees in Germany to learn the recommended vocabulary and the textbook vocabulary. The means and standard error were 4.61 and 0.53 for the textbook vocabulary, and 4.85 and 0.25 for the vocabulary recommendation (t=2.52,p<0.05). It was found that the motivation of the participants to learn the recommended vocabulary was significantly higher than the motivation to learn the textbook vocabulary. This implies that the recommended vocabulary improved the motivation of the Syrian refugees in Lebanon to learn the recommended words and further similar words, compared to what they usually learn in their textbooks.

Table 4.5. shows the results of the motivation for the Syrian refugees in Germany to learn the recommended vocabulary and the textbook vocabulary. The means and standard error were 4.01 and 0.47 for the textbook vocabulary, and 4.81 and 0.27 for the vocabulary recommendation (t=6.04,p<0.01). It was found that the motivation of the participants to learn the recommended vocabulary was significantly higher than the motivation to

Table 4.4: Learning motivation in Lebanon

Method	N	Mean	SD	SE	t	df
Textbook Vocabulary	25	4.61	0.53	0.11	2.52*	24.00
Vocabulary recommendation	25	4.85	0.25	0.05		

*$p < 0.05$

learn the textbook vocabulary. This implies that the recommended vocabulary improved the motivation of the Syrian refugees in Germany to learn the recommended words and further similar words, compared to what they usually learn in their textbooks.

Table 4.5: Learning motivation in Germany

Method	N	Mean	SD	SE	t	df
Textbook Vocabulary	12	4.01	0.47	0.14	26.04**	11.00
Vocabulary recommendation	12	4.81	0.27	0.80		

**$p < 0.01$

4.4 Conclusions

In this work we collected the vocabulary needed by Syrian refugees in transition in Lebanon, and settling in Germany, and recommended them further vocabulary. The need-based vocabulary recommendation was extracted based on the past learning history of 38 Syrian refugees in Lebanon and Germany. The results confirm that different vocabulary is needed by Syrian refugees in Lebanon and Germany. Moreover, the results show that the learning achievement and motivation of the participants significantly increase when learning the recommended vocabulary, versus learning their assigned textbook vocabulary.

Chapter 5

Translating vocabulary: Identifying the intended meaning of the learner using the informal learning activity

5.1 Introduction

A growing number of language learners are using informal language learning applications to learn new vocabulary anytime and anywhere. Dictionaries and online translators are learners' preferred language learning tools [29], with Google Translate being the most used translation tool [31]. Mobile translators or informal vocabulary learning systems allow language learners to input a word they wish to learn, get the translation, and save it as a log for future review sessions. Learners encounter issues with translation when they encounter words that can have several meanings depending on the context. These are known as polysemous words and homographs. A polysemous word is a word that has different meanings that derive from a common origin; a homograph is a word that has different meanings with unrelated origins. Polysemous words and homographs are known to constitute a problem for language learners.

Online translators usually provide users with the translation of only one of the meanings of the target word. Learners do not have the opportunity to indicate the meaning of the word they are looking up when learning vocabulary in an informal language learning environment. This can cause learners to learn words out of their context of use, eventually leading to miscommunication. In fact, language learners face difficulties figuring out the correct translation for their intended meaning [16]. Even when using a dictionary, learners tend to look at the top entry, and will rarely refer to other entries [52]. For a

better comprehension of the vocabulary, it is important to provide the learners with the translation they are looking for. To provide the learners with the translation they want, we need to first identify their intended meaning when they translate isolated polysemous words.

Classical Word Sense Disambiguation (WSD) techniques are unable to disambiguate isolated words as they require a text or sentences surrounding the target word to give a context for the disambiguation. In this respect, informal language learning applications could provide us with a new kind of context to identify a learner's intended meaning. In fact, language learners tend to learn words inspired by their activities or surroundings [98]. Moreover, informal vocabulary learning systems allow the gathering of the user's digital trace, which is formed by all the learning logs created by the user on the system. A learning log usually includes the word that has been learned, the location and time of learning, and a photo or video associated with the word. Learning logs have been used for contextual vocabulary learning purposes. Some typical use cases include teaching words to users in a specific location that other users learned in a similar location, or reminding users of words they learned previously when they return to a specific place [83]. This digital trace could also be used as a context to disambiguate isolated words and provide the appropriate translation to the learner. Even though the learners' digital trace is increasingly available, it has not yet been used as a context to identify the intended meaning of language learners.

When language learners look up an isolated word in a translation tool, or in an informal language learning environment that incorporates a translation tool, they don't have access to the surrounding text that would give the context needed to disambiguate the word. In this work, we propose to use the learners' past logs as a context to identify their intended meaning when they translate isolated homographs or polysemous words in an informal language learning environment. We propose three different methods that aim to identify the learner's intended meaning based on the semantic similarity between the learner's past vocabulary and the different meanings of the target word. The method is evaluated on users of the SCROLL system (System for Capturing and Reminding Of Learning Log) [83]. SCROLL is an informal language learning application in which users record the words they have learned in their daily lives. The proposed methods could enable the design of systems that provide language learners with translations based on their intended meaning, essential to the improvement of their vocabulary learning and

communication skills. Considering all of the above, the two objectives of this work can be stated as:

- to demonstrate that the logs generated in an informal language learning environment can be used to identify a learner's intended meaning when they look up or translate isolated polysemous words.

- to propose methods to identify a learner's intended meaning when they translate polysemous words in an informal language learning environment.

5.2   Background

5.2.1   Polysemy and technology supported vocabulary learning

A recent study shows that second language learners better learn a word by associating it with the translation of that word in their first language, then by associating it to with their definition of the word in the second language [54]. In other terms, second language learners benefit from learning a new word with its equivalent translation in their first language.

However, the meaning of a word changes from one context to another, as does its translation. In fact, about 40% of English words have more than one meaning listed in a dictionary [77]. This number includes polysemous words – words that have several related meanings–and homographs, i.e., words that have several unrelated meanings. In a dictionary, polysemous words have different meanings under the same entry, whereas homographs are listed in multiple entries.

Polysemous words and homographs can be problematic to self-directed language learners. In fact, learners have difficulties knowing the correct translation of a word or which meaning they should choose in order to use a word in a specific context [16]. Of course, second language learners can always refer to a dictionary that provides detailed definitions as well as examples of usage. However, most learners prefer bilingual dictionaries [10, 16] which usually lack rich lexico-grammatical information [16]. Moreover, bilingual language dictionaries order the words by meaning frequency. Users tend to look at the top entry and will not refer to other entries unless the first one is obviously wrong. Google translate is the most used online tool amongst language learners [52]. Machine translation of single words provides the user with one translation that usually consists of the most

common meaning. Using this kind of simplified bilingual dictionary or online translator can lead language learners to learn a different translation then the one appropriate to their intended context of use.

Language learners would benefit from getting the appropriate translation in their intended context of use [77]. In a classroom environment, a learner has the opportunity to communicate their intended usage of a word with multiple meanings to the teacher, and subsequently learn the appropriate translation of the word. However, in an informal and distant learning environment, language learners cannot state the meaning of the word they are looking for. This is especially true when learners are looking up translations of single words. One obvious solution would be to provide the learner with a list of definitions and corresponding translations. However, if given such a list, learners may still find it difficult to identify the meaning they are looking for.

Miller and Gildea suggest that definitions should be given in the context encountered by the learner during the moment of learning instead of in a list of different dictionary definitions [73]. Providing the learners with a translation that corresponds to their intended meaning requires adaptivity to individual users. Most of today's applications do not adapt to the needs of individual learners, and a more adaptive learning would provide a more personalized experience in terms of the content delivered during instruction [44].

However, dictionaries and informal vocabulary learning applications used today register the lifelong activity performed by language learners and can be considered a form of lifelogging. Lifelogging is defined as a digital record of what a learner has learned in their daily life using ubiquitous computing technologies. Lifelogging systems can be used to help understand the user and their intended meaning when they look up a word in the system. Lifelogging systems provide information on the user's environment and the information needs of the user. These systems give insight into what the user is experiencing and learning at any point in time and any moment prior to it. Lifelogging systems offer the potential to tailor information to the user in response to an information need [41].

5.2.2   Word sense disambiguation and vocabulary learning

Word Sense Disambiguation (WSD) is a well-established field and a common problem of natural language processing. The objective of WSD is the identification of the most proper (dictionary) definition for an ambiguous word in a given context. In computational linguistics, the context usually consists of the words and sentences that occur around the

target word [28]. WSD has been used for vocabulary learning purposes. However, to our knowledge, all previous studies worked on disambiguating words that were encountered within a text; therefore their aim was to identify the meaning intended by the author of the text. WSD has been used to help learners with their reading comprehension and vocabulary learning by providing them context-specific definitions while they are reading a text [34, 11]. However, when language learners look up the definition or translation of isolated words, text surrounding polysemous words is not available to give context for disambiguation and learners might end up learning the translation that does not correspond to their intended context. In this work, we propose using learners' past logs to identify their intended meaning.

5.3   Methods

5.3.1   Data collection from an informal distance language learning environment

The informal language learning environment used in this study is the SCROLL system.

When a user wants to learn a new word, they create a new log, log_n. Unless the user is new to the system, their profile already contains their previous logs: $log_1, log_2, \ldots, log_{n-1}$. Each log is constituted by a word, an image, a location and a time of input.

$log = \{word, image, location, time\}$

Even though a $word$ can have more than one meaning, SCROLL displays only one translation to the user, using Microsoft Translator Text API.

Figure 5.1 shows the typical usage of SCROLL. The user saves a new word they want to learn, depending on their specific context. In the picture for example, the learner encountered a tree and wanted to translate it to the target language. They input the word tree in their native language. The word is automatically translated to the target language. Moreover, the time and location are saved automatically, and the user is able to attach an image to the log. In this case, the user attached the picture of a rainbow. The user can also have access to their previous logs, or look at other users' logs. Figure 5.1 shows that the past logs of the learner included the words rainbow, lamp, and plush.

Figure 5.1: Log creation and past logs on SCROLL

5.3.2 General and situated vocabulary in the users' digital trace

To understand the patterns of vocabulary logging using an informal language learning environment, we selected 20 SCROLL users and analyzed their learning activity. We picked the users randomly from a larger user group that was selected based on the following criteria:

- Users that have English as a first Language.

- Users that have used SCROLL for more than three months.

- Users that have input more than 50 logs.

The chosen criteria allows for the analysis of the activity of users who used SCROLL regularly for an extended period of time.

Through an initial examination of the logs of the selected users, we found that the users' logs contain words that are semantically similar. Certain words belonged to a general vocabulary present throughout all the users logs, while other words belonged to a situated vocabulary present in logs created within a short and limited period of time.

- General vocabulary: learners tend to have several words throughout their logs that belong to the same semantic fields. Those words constitute general vocabulary in the users' digital trace. The general vocabulary may be related to the users' interests, fields of study or work. E.g.: botanic, animals, computer-science, etc.

- Situated vocabulary: Learners tend to save words belonging to the same semantic field within a short and limited period of time. E.g.: 12:55 pm, cat; 12:56 pm: dog; 12:56 pm: hamster; 12:57 pm: bird.

Figure 5.2 is an example of the presence of the situated and general vocabulary within a section of the vocabulary of one of the twenty selected users. The semantic fields associated to the words are based on a thematic analysis of the vocabulary of the learner. In Figure 5.2, the learner has three general vocabularies that were repeated throughout their logs. The general vocabularies belong to the semantic fields of astronomy, supernatural and chemistry. Moreover, the learner has several situated vocabularies that were logged within a short period of time and were not repeated throughout the logs.

Date of input	Word logged by the user	Semantic field
2017/06/22 15:42	public transportation	
2017/06/22 15:42	refreshing	
2017/06/22 15:43	neighbor	
2017/06/22 15:44	comet	astronomy
2017/06/22 15:45	mercury (planet)	astronomy
2017/06/22 15:45	venus (planet)	astronomy
2017/06/22 15:46	earth (planet)	astronomy
2017/06/22 15:46	mars (planet)	astronomy
2017/06/22 15:47	jupiter (planet)	astronomy
2017/06/22 15:47	saturn (planet)	astronomy
2017/06/22 15:48	uranus (planet)	astronomy
2017/06/22 15:49	neptune (planet)	astronomy
2017/06/22 15:49	pluto (planet)	astronomy
2017/06/22 16:00	telescope	astronomy
2017/06/22 16:01	star	astronomy
2017/06/22 16:02	horoscope	supernatural
2017/06/22 16:04	charm	supernatural
2017/06/22 16:06	written oracle	supernatural
2017/06/22 16:09	magical power	supernatural
2017/06/22 16:17	astronomy	astronomy
2017/06/22 16:19	macro-molecule	chemistry
2017/06/22 16:21	carbon	chemistry
2017/06/22 16:22	hydrogen	chemistry
2017/06/22 16:22	oxygen	chemistry
2017/06/22 16:23	nitrogen	chemistry
2017/06/22 16:27	prohibition	
2017/06/22 16:28	emergency exit	
2017/06/22 16:31	aquarium	marine
2017/06/22 16:31	marine biology	marine
2017/06/22 16:35	milky way	astronomy
2017/06/22 16:38	observation	

Date of input	Word logged by the user	Semantic field
2017/06/22 16:51	barber	haircut
2017/06/22 16:58	barbershop	haircut
2017/06/22 17:10	grave	death
2017/06/22 17:11	graveyard	death
2017/06/23 14:39	ghost	supernatural
2017/06/23 14:39	spirit	supernatural
2017/06/23 14:41	revengeful ghost	supernatural
2017/06/23 14:44	cheap sweets	sweets
2017/06/23 14:44	small-time candy store	sweets
2017/06/23 14:49	tuition fee	
2017/06/23 14:51	sulfuric acid	chemistry
2017/06/23 14:52	nitric acid	chemistry
2017/06/23 14:53	hydrochloric acid	chemistry
2017/06/23 14:55	military power	
2017/06/23 15:00	carrot	
2017/06/23 15:15	haunted house	supernatural
2017/06/23 15:50	desert	geology
2017/06/23 15:53	volcano	geology
2017/06/23 15:54	plateau	geology
2017/06/23 15:55	angel	supernatural
2017/06/23 15:56	fallen angel	supernatural
2017/06/23 15:57	demon	supernatural
2017/06/23 16:00	accomplice	
2017/06/23 16:00	married woman	
2017/06/25 10:07	dentistry	medicine
2017/06/25 10:08	internal medicine	medicine
2017/06/25 10:19	zymase (enzyme)	chemistry
2017/06/25 10:21	polysaccharide	chemistry
2017/06/25 10:45	ghost story	supernatural
2017/06/25 11:11	mackerel	fish
2017/06/25 11:13	red seabream	fish

Date of input	Word logged by the user	Semantic field
2017/06/25 11:14	seabass	fish
2017/06/25 11:23	exorcism (shinto ritual)	supernatural
2017/06/25 11:45	bow & arrow	
2017/06/25 11:47	archer	
2017/06/26 18:23	detective	crime
2017/06/26 18:24	police inspector	crime
2017/06/26 18:25	suicide	crime
2017/06/26 18:26	murder	crime
2017/06/26 18:27	murder case	crime
2017/06/26 18:31	dragon	
2017/06/26 18:32	familiar	
2017/06/26 18:33	witch	supernatural
2017/06/26 18:34	sorcerer	supernatural
2017/06/26 18:38	application form	
2017/06/26 18:40	goddess	supernatural
2017/06/26 18:45	union	
2017/06/26 18:50	scorpion	animal
2017/06/26 18:51	wolf	animal
2017/06/26 18:53	fox	animal
2017/07/10 18:28	constellation	astronomy
2017/07/10 18:47	courage	
2017/07/10 18:48	chrysanthemum	
2017/07/11 16:45	excellence	
2017/07/11 16:48	sixth sense	supernatural
2017/07/11 16:49	spell	supernatural

Legend:	Situated Vocabulary
	General vocabulary: astronomy
	General vocabulary: supernatural
	General vocabulary: chemistry

Figure 5.2: General and situated vocabulary in the vocabulary of a SCROLL user

Supposing that we aim to identify the intended meaning of a learner's mth log. The past vocabulary of learner is composed of $m-1$ words.

$$vocab = word_1, word_2, ..., word_{m-1}$$

Based on the previous observations, we divide the vocabulary of a learner ($vocab$) into two different sets: $vocab_{general}$ that includes all the words that were inserted in the system more than five minutes before the target word, and $vocab_{situated}$ that includes the words that were inserted in the system within five minutes of the insertion of the target word.

$$vocab = vocab_{general} + vocab_{situated}$$

5.3.3 Identification of the user's intended meaning

In this section, we present three different methods to identify a learner's intended meaning when she/he looks up a word that has multiple meanings. The methods use the learner's past logs to identify their intended meaning. For the three different methods, we suppose that a word has n meanings:

$$word = meaning_1, meaning_2, ..., meaning_n$$

$Method1$: **Identification of the intended meaning of a learner based on the general vocabulary**

In this method we use the $vocab$ of a learner to identify their intended meaning. We consider that the meaning that has the highest semantic similarity with the past vocabulary is the intended meaning of the learner, as follows:

$$identifiedMeaning = \max\{(semanticSimilarity(meaning_1, vocab),$$
$$semanticSimilarity(meaning_2, vocab), ...,$$
$$, semanticSimilarity(meaning_n, vocab))\}$$

Example   To illustrate how $Method1$ works, let's suppose that the language learner is translating and logging the word $calf$ at 15:26. In this case, the word $calf$ has two different meanings:

$meaning_1$: veal

$meaning_2$: soleus

Table 5.1 shows the learner's vocabulary with the dates and time of input of each word:

To identify the intended meaning of the learner we compute the following semantic similarities:

Table 5.1: Learner's vocabulary and time of input

word	time
thigh	2018/11/08 15:25
knee	2018/11/08 15:24
elbow	2018/11/08 15:18
lantern	2018/11/08 15:08
finger	2018/11/04 21:07
Thumb	2018/11/04 21:06
little	2018/11/04 21:05
finger	2018/11/04 21:05
nut	2018/11/03 14:15
rice	2018/11/03 14:14
paddy	2018/11/03 14:14
nail	2018/11/03 14:08
scissors	2018/11/03 14:08

$$semanticSimilarity(veal, (thigh\ knee\ elbow\ lantern$$
$$finger\ thumb\ little\ finger\ nut\ rice\ paddy\ nail\ scissors$$
$$thermometer\ toothpaste\ shaver))$$

$$semanticSimilarity(soleus, (thigh\ knee\ elbow\ lantern$$
$$finger\ thumb\ little\ finger\ nut\ rice\ paddy\ nail\ scissors$$
$$thermometer\ toothpaste\ shaver))$$

If the semantic similarity between the word *veal* and the past vocabulary is the highest, we consider that the learner should get a translation for *veal*, as it is his/her intended meaning. Otherwise, we consider that *soleus* is the intended meaning of the learner.

$Method2$: **Word meaning identification based on general and situated vocabulary**

Similarly to $Method1$, the intended meaning of the learner is the meaning that has the highest semantic similarity with the past vocabulary. However, $vocab_{situated}$ can provide a more precise context regarding the intended meaning of the learner. Thus, ten times more weight is given to the semantic similarity between $vocab_{situated}$ and the different

meanings of the target word, compared to $vocab_{general}$ and the different meanings of the target word.

$$
\begin{aligned}
identifiedMeaning = \max\{ & (10 * semanticSimilarity(meaning_1, vocab_{situated} \\
& + semanticSimilarity(meaning_1, vocab_{general}), \\
& (10 * semanticSimilarity(meaning_2, vocab_{situated} \\
& + semanticSimilarity(meaning_2, vocab_{general}), \\
& (10 * semanticSimilarity(meaning_n, vocab_{situated} \\
& + semanticSimilarity(meaning_n, vocab_{general})))\}
\end{aligned}
$$

Example   To illustrate how $Method2$ works, let's suppose again that the language learner is translating and logging the word $calf$ at 15:26. As stated previously, the word $calf$ has two different meanings:

$meaning_1$: veal

$meaning_2$: soleus

Table 5.2 shows the learner's vocabulary with the dates and time of input of each word:

Table 5.2: Learner's vocabulary and dates of input

word	time
thigh	2018/11/08 15:25
knee	2018/11/08 15:24
elbow	2018/11/08 15:18
lantern	2018/11/08 15:08
finger	2018/11/04 21:07
Thumb	2018/11/04 21:06
little	2018/11/04 21:05
finger	2018/11/04 21:05
nut	2018/11/03 14:15
rice	2018/11/03 14:14
paddy	2018/11/03 14:14
nail	2018/11/03 14:08
scissors	2018/11/03 14:08

The words $thigh$ and $knee$ constitute $vocab_{situated}$ as they were inputted within five minutes of the target word $calf$. The rest of the vocabulary constitute $vocab_{general}$. To

identify the intended meaning of the learner we compute the following semantic similarities:

$$10 * semanticSimilarity(veal, (thigh\ knee))+$$
$$semanticSimilarity(veal, (elbow\ lantern\ finger$$
$$thumb\ little\ finger\ nut\ rice\ paddy\ nail\ scissors$$
$$thermometer\ toothpaste\ shaver))$$

$$10 * semanticSimilarity(soleus, (thigh\ knee))+$$
$$semanticSimilarity(veal, (elbow\ lantern\ finger$$
$$thumb\ little\ finger\ nut\ rice\ paddy\ nail\ scissors$$
$$thermometer\ toothpaste\ shaver))$$

If the semantic similarity of the word *veal* with the past vocabulary is the highest, we consider that *veal* is the meaning the learner should get a translation for, as it is her/his intended meaning. Otherwise, we consider that *soleus* is the intended meaning of the learner.

*Method*3: Word meaning identification based on previous logs and most common definition

The semantic similarity between different meanings of the target word and the vocabulary sometimes have very similar values. In those cases, the results of the previous methods are not a strong indicator of the intended meaning of the learner. In such situations, we propose considering that the most common meaning of the target word is the intended meaning of the learner. The semantic similarities are considered similar if their ratio varies between 0.8 and 1. In the cases where the ratio of the semantic similarities is lower than 0.8, we use the general and situated vocabulary to identify the intended meaning of the learner as shown in *Method*2. To identify the most common meaning, we use the first entry of the New Oxford American Dictionary. The entries of each word in the New Oxford American Dictionary are ordered by meaning frequency, i.e., how common the meaning is in today's English.

`if` $semanticSimilarity(meaning_i, vocab)/semanticSimilarity(meaning_j, vocab)$
$<= 0.8$

then $identifiedMeaning = MostcommonMeaning$

else

$$identifiedMeaning = \max\{(10 * semanticSimilarity(meaning_1, vocab_{situated}$$
$$+ semanticSimilarity(meaning_1, vocab_{general}),$$
$$(10 * semanticSimilarity(meaning_2, vocab_{situated}$$
$$+ semanticSimilarity(meaning_2, vocab_{general}),$$
$$(10 * semanticSimilarity(meaning_n, vocab_{situated}$$
$$+ semanticSimilarity(meaning_n, vocab_{general})))\}$$

5.4 Results

5.4.1 Setup of the evaluation

More than 40% of English words are polysemous words. In order to restrict the number of words, we limit our evaluation to homographs. Homographs are words that look similar but have different origins and different meanings. The difference between polysemous words and homographs is subtle. Lexicographers define polysemous words within a single dictionary entry, numbering different meanings, while homographs are treated in separate dictionary entries.

Our list of homographs is based on Stork's list of homographs from the New Oxford English Dictionary [102]. We confirm the homographs on the list by checking if each of the words has at least two different entries in the Oxford American Writer's Thesaurus. The words that have two or more entries constitute our final list of homographs.

In order to identify the intended meaning of the learner, we first need to compile a list of possible meanings. For each homograph, the list of possible meanings was compiled as a list of synonyms representing its different possible meanings, e.g., fan: meaning 1: ventilator; meaning 2: admirer.

We select from SCROLL the logs that contain an English homograph, as well as an image associated to them. This selection results in 148 logs. The 148 logs containing homographs belong to 78 different users. The semantic similarity is computed between each meaning of the homograph and the past vocabulary of the user that input the homograph. The past vocabulary of each author of the homographs contains an average of 127 logs. The total number of logs used to disambiguate the homographs is 9906.

The semantic similarity is calculated using the cosine similarity of the open-source toolkit Gensim [89]. We train a Wikipedia-based word embedding using English Wikipedia with Gensim Word2Vec tool. We run the algorithm for the three different methods and obtain the identified meaning for each homograph. To evaluate if our identified meaning is in fact the intended meaning of the learner, we compare it to the image uploaded by the learner. The comparison is manual, and if the identified meaning corresponds to the image uploaded by the learner, the meaning identification is considered successful. In the cases where the image does not match the identified meaning, we consider that the meaning disambiguation is a failure.

For further evaluation of our results, we compare them to Google Translate as it is the most used language learning tool. However, Google Translate results differ depending on the chosen pair of languages and the proposed methods are independent of the target language. To tackle the issue, we chose to compare our results to those of Google Translate for the English-Japanese, English-Arabic, and English-French language pairs. Arabic, French and Japanese belong to different language families. Moreover, French and English belong to the same family of Indo-European languages. This diversity in the target languages could provide a better understanding of the success rates of the proposed methods compared to Google Translate. We translate the same set of logs to Japanese, Arabic and French. If the translation provided by Google Translate corresponds to the intended meaning of the learner, we consider the translation successful. If not, the translation is considered a failure. Speakers of Japanese, Arabic, and French identified the meaning provided by Google Translate and reported whether it corresponds to the image uploaded by the learner.

5.4.2 Results of the evaluation

$Method1$, $Method2$, $Method3$ result in 72.18%, 75.63%, and 83.05% of correctly identified meanings respectively. We compare the results of the proposed methods to Google Translate results on the same set of logs. As Google Translate results differ depending on the chosen pair of languages, we compare our results to those of Google Translate for the English-Japanese, English-Arabic, and English-French language pairs. Google Translate provides an identification success rate of 75.62% from English to Japanese, 71.42% from English to Arabic, and 88.72% from English to French. Table 5.3 provides a summary of the results. Moreover, a chi-square test was conducted to examine whether the im-

Table 5.3: Evaluation of the methods and comparison with Google Translate on the same set of logs

	Method1	Method2	Method3	Google Translate En-Jp	Google Translate En-Ar	Google Translate En-Fr
Identification rate	72.18%	75.63%	83.05%	75.62%	71.42%	88.72%

provement between Method 1 and Method 3 is significant. The chi-square test showed that the difference between Method 1 and Method 3 is significant $X^2(1,N=148)=4.068$, p=.043702.

5.4.3 Analysis of the results

Methods 1, 2 and 3 provided a success rate that is superior to the results of Google Translate with the same set of logs from English to Arabic. Methods 2 and 3 surpassed the results of Google Translate from English to Japanese. However, Google Translate surpassed the three methods when translating the provided set of words from English to French. This could be due to the fact that both English and French are Indo-European languages and contain numerous cognates [105], whereas Arabic belongs to the Afro-Asiatic language family and Japanese to the Japonic language family [36]. This shows that providing translation based on a language learner's past vocabulary can potentially be language independent, i.e., it is not influenced by how two different languages are related.

To have a deeper understanding of the situations in which the three proposed methods failed to identify the intended meaning of the learner, we collected the list of unsuccessful identifications, manually analyzed the reason behind the failure and grouped them into the following categories:

- Past vocabulary semantically closer to unintended meaning: Methods 1, 2, and 3 failed to identify the intended meaning of the learner when the past vocabulary was semantically closer to an unintended meaning. This category is the most general one as well as the most populated one.

  Example

Target word: fan

Meanings of the word: $admirer$, $ventilator$

Past vocabulary of the learner: $concert, singer, song, poster$

Intended meaning identification with proposed methods: $admirer$

Picture uploaded by the learner representing their intended meaning: $ventilator$

Reason of failure: The past vocabulary of the learner indicates that the intended meaning of the learner is the meaning of $admirer$ whereas it is the meaning of $ventilator$.

- Different definitions of a word are semantically close: In a small number of cases, the different meanings of the target word were semantically close to each other, resulting in a misidentification of the intended meaning of the learner.

  Example

  Target word: $book$

  Meanings of the word: $notebook$, $textbook$, $reserve$

  Past vocabulary of the learner: $write, study, read, school$.

  Intended meaning identification with proposed methods: $notebook$

  Picture uploaded by the learner representing their intended meaning: $textbook$

  Reason of failure: The past vocabulary of the learner is semantically close to two of the meanings of the word $book$: $notebook$ and $textbook$. The identified meaning was $notebook$ as it had a slightly higher score with the proposed methods. However, the actual intended meaning of the learner was $textbook$.

- Only the situated vocabulary is semantically close to the intended meaning: In some cases, the overall past vocabulary of the learner was semantically closer to the unintended meaning, whereas the situated vocabulary was semantically closer to the intended meaning of the learner. This case led to a failure of identification in $Method1$ only, as the issue was solved in Methods 2 and 3.

  Example

  Target word: fan

  Meanings of the word: $admirer$, $ventilator$

  Past vocabulary of the learner: 12:01 $concert$, 12:03 $singer$, 15:09 $song$, 15:09 $actor$,

15:10 *movie*, 15:54 *poster*, 19:32 *hot*, 19:33 *summer*, 19: 34 *wind*, 19:35 *blow*

Intended meaning identification with proposed methods: *admirer*

Picture uploaded by the learner representing their intended meaning: *ventilator*

Reason of failure: The general vocabulary of the learner (until 15:54) is semantically closer to the meaning of *admirer* whereas the situated vocabulary is closer to the meaning of *ventilator*, which is the intended meaning of the learner. As the general vocabulary is bigger than the situated vocabulary, $Method1$ misidentified the intended meaning. This kind of misidentification was eliminated from $Method2$ and $Method3$ by giving more weight to the situated vocabulary.

- Few past vocabulary: In some cases, the past vocabulary of the learner was formed by very few words (one to five), and did not contain any particular pattern.

  Example

  Target word: fan

  Meanings of the word: *admirer*, *ventilator*

  Past vocabulary of the learner: *water*

  Intended meaning identification with proposed methods: *admirer*

  Picture uploaded by the learner representing their intended meaning: *ventilator*

  Reason of failure: The past vocabulary is too small and contains words unrelated to both meanings of the target word

- Situated vocabulary semantically closer to unintended meaning: In some cases, the general past vocabulary of the learner was semantically closer to the intended meaning, whereas the situated vocabulary was strongly closer semantically to the unintended meaning. This issue led to identification failures in the cases of $Method2$ and $Method3$.

  Example

  Target word: fan

  Meanings of the word: *admirer*, *ventilator*

  Past vocabulary of the learner: 19:32 *hot*, 19:33 *summer*, 19: 34 *wind*, 19:35 *blow*, 19:55 *swing*, 20:21 *blades*, 20:30 *folded*, 20:40 *concert*, 21:41 *singer*, 21:41 *song*, 21:42 *actor*

Intended meaning identification with proposed methods: *admirer*

Picture uploaded by the learner representing their intended meaning: *ventilator*

Reason of failure: The situated vocabulary of the learner (from 21:41 to 12:42) is semantically closer to the meaning of *admirer* whereas the general vocabulary is closer to the meaning of *ventilator*, which is the learner's intended meaning. As the situated vocabulary has a bigger weight than the general vocabulary in $Method2$ and $Method3$, the intended meaning was misidentified. This kind of misidentification only occurred in $Method2$ and $Method3$.

- The most common meaning is not the intended meaning: $Mehtod3$ failed to identify the intended meaning in some cases when the different meanings of the target word had similar semantic similarity with the past vocabulary, and the most common meaning of the word happened to be the unintended meaning of the learner.

  Example

  Target word: *calf*

  Meanings of the word: *veal, soleus*

  Past vocabulary of the learner: *animal, knee, leg, cow*

  Intended meaning identification with proposed methods: *veal*

  Picture uploaded by the learner representing their intended meaning: *soleus*

  Reason of failure: The past vocabulary is as semantically close to both meanings of the word *veal*. In those cases, $Method3$ selects the most common meaning. In this case, the most common meaning of the word *calf* is the meaning of *veal*. However, the learner uploaded a picture that represents the *soleus*.

Figure 5.3 shows the reasons of failure of the different methods as well as their distribution.

5.5   Discussion

This paper shows the potential that informal vocabulary learning environments have to provide language learners with personalized translations based on their learning activity. Learners choose the words they want to learn. Their choice of words does not come
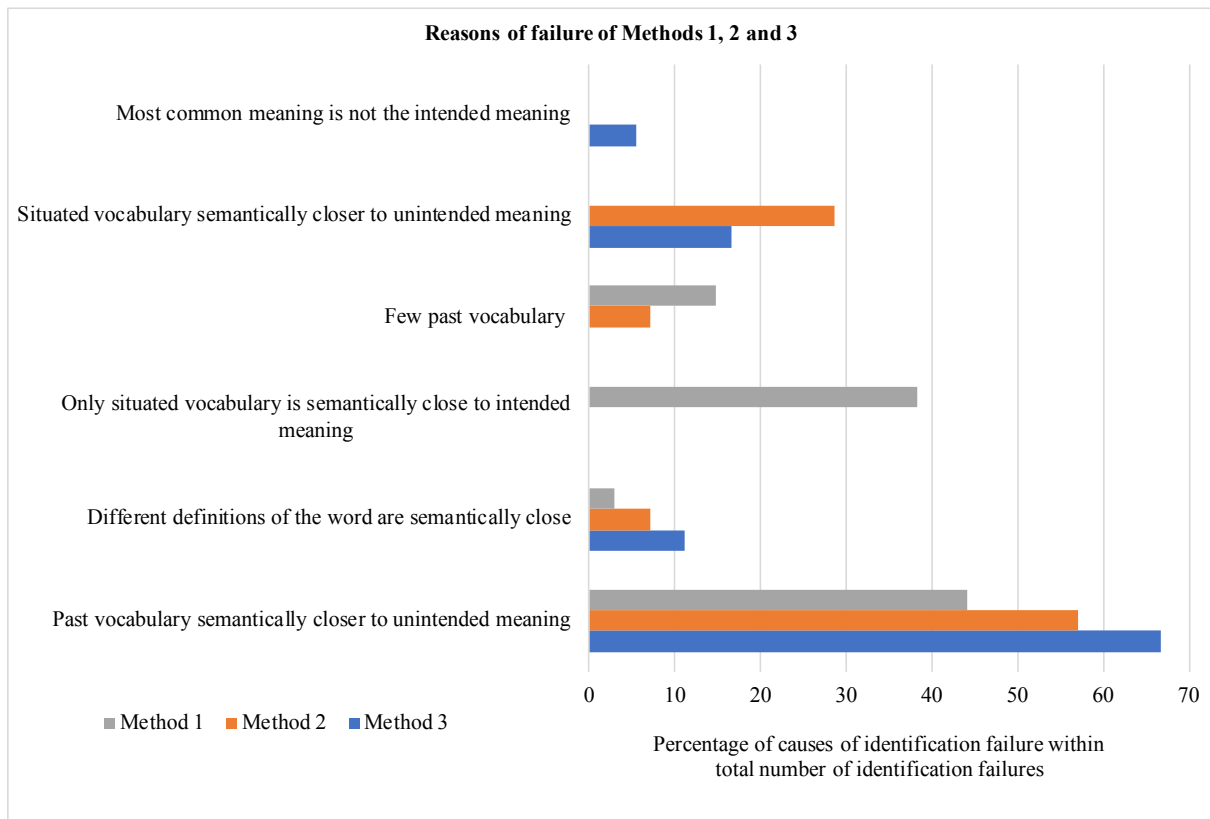
Figure 5.3: Reasons of failure of Methods 1, 2 and 3.

from a list in a textbook, but from the learner's interests, activities and surroundings. We proposed methods to identify the learners' intended meaning when they look up a polysemous word or homograph. If applied, those methods can lead to a personalized and contextualized translation that is beneficial to the learning process.

Considerations and opportunities Learning the correct translation in the intended context of use could improve the learner's communication skills or reading comprehension skills. However, even though the intended meaning of the learner is identified and shown to them, the learner should still be exposed to all the different meanings of a word, and be aware of the existence of different meanings in different contexts of use. Highlighting the intended meaning would help the learner memorize and connect the translation to their current context.

If the language learner is following language classes with the help of an instructor, word sense disambiguation could help the language teacher track writing mistakes based on the intended meaning of the learner. For example, in situations where students submit

written compositions through a Learning Management System (LMS), the LMS could be linked to their learning logs. The teacher could then view not only the written composition but also the words that the learner looked up and used in their writing, as well as the intended meaning of the student in the cases of polysemous words. Understanding the learner's intended meaning would give the teacher the opportunity to check if the usage of the word was correct in the sentence and give feedback on a better formulation based on the intended meaning. Moreover, the teacher could then give detailed explanations on the most appropriate form of usage in the particular context intended by the student.

Moreover, numerous studies have shown a correlation between trust in and usage of a system [66, 75]. Privacy concerns and uncertainties negatively affect the usage of a system [112]. SCROLL's users did not enable the location on 65.7% of SCROLL's logs. Enabling the location on SCROLL does not require much effort as SCROLL displays a notification upon login asking the user for permission to enable the location. Moreover, enabling the location in SCROLL would offer the users benefits like location-based word recommendations. Even though enabling the location services is easy and useful, many users choose not to do it, implying they may lack trust in the system. The methods proposed identify the intended meaning of the learner using their past activity and might create privacy concerns. To maintain the trust of the user, the system has to maintain transparency and the user has to be aware of the method behind the word meaning disambiguation and give consent to use their past activity for a personalized translation.

If extended, this work could be a first step towards identifying false friends situations when language learners are learning a new language. In fact, to point out to language learners that they are encountering a false friend that might be be misleading for them, we should be able to first identify their intended meaning [1].

Limitations The number of logs analyzed is quite small as we had three main restrictions: the logs had to contain an English word, the word had to be a homograph, and the learner had to have an image uploaded in order to confirm our meaning identification. However, the results of the methods clearly show that the past activity of a learner in an informal learning environment is a good indicator of their intended meaning.

In the proposed methods, we considered that the situated vocabulary is the vocabulary saved within a short period of time of the target word, giving it a temporal definition. SCROLL in particular, and informal language learning environments in general, allow

the capture of the user's location while logging a new word. Another option would be to use the location to define what constitutes the situated vocabulary. However, in our available data, many users did not allow the system to access their location, others saved improbable locations (e.g., "the sea"), and some users were continuously using the system from only one location. As the available data represents real life situations and challenges, we considered that a temporal division would be more reliable in identifying the intended meaning of the learner. A temporal definition of the situated vocabulary can represent the spatial aspect when the user does not permit access to their location. Moreover, the temporal definition includes situations in which the user changes activities or studies different subjects without moving locations.

An important limitation of this paper lies in the evaluation itself. To evaluate the success or failure of the intended meaning identification, we rely on the images uploaded by the learner. However, the images uploaded by the users represent objects or places, as it is difficult to find or take pictures representing abstract concepts. This factor resulted in a selection of logs, where the intended meaning of the learner relates mostly to objects. This limitation does not deny the potential shown by the results in identifying the intended meaning based on past vocabulary. However, a different evaluation should be designed to include non-material concepts in the set of logs studied.

A failure to identify a leaner's intended meaning occurred in cases in which the users of SCROLL had no or very few past vocabulary words saved on the system. $Method3$ tackles part of the problem by selecting the most common definition of a word when different definitions have similar semantic similarities with the past vocabulary. Thus, $Method3$ allows the selection of the most common definition in cases in which there is no previous vocabulary uploaded by the learner. However, $Method3$ failed to predict the intended meaning when the learner had saved only a few words previously, and those words happened to be significantly more semantically similar to the unintended definition of the target word. It would be important to determine the size of the vocabulary needed in order to have a reliable outcome when applying the method.

Another limitation is imposed by the different meanings we chose for the isolated words. In this paper, we selected the first synonym for each meaning in the Oxford American Writer's Thesaurus. We then computed the semantic similarity between the synonym and the past vocabulary of the learner. Choosing different synonyms might have led to different semantic similarities. Another alternative would be to consider the whole

definition of the word as a meaning, and compute the semantic similarity between the definition and the past vocabulary of the learner.

Homographs have different meanings that are clearly not related to each other. A typical example is the word *bank*, with one meaning being *financial institution* and the other referring to the *side of a river*. However, the meanings of a polysemous word have a common origin and some of them are highly semantically related [68]. For example, the word *book* could mean a *printedwork* or a *bound set of blank sheets for writing in*. In the work, we considered homographs to test the method and this allowed us to avoid situations where the meanings were very similar to each other and belonged to the same semantic fields. It would be more difficult to pinpoint the exact meaning the learner is looking for if we had also considered polysemous words. However, this could be solved by providing the learner all of the definitions that could correspond to their intended meaning, eliminating meanings that are very semantically far from the intended meaning. Providing different definitions would still teach the learner the meaning(s) of a word in its intended context of use.

Finally, with the increase of the number of logs on the system, identifying the intended meaning could slow down the system and affects its usability. Designers should make sure that the usability of the system is preserved in terms of optimizing the databases for the big amount of data. New models of databases could be considered to address the limitations of traditional databases [47].

5.6 Conclusion

In this work, we aimed to identify the intended meaning of language learners when they look up a polysemous word or a homograph in an informal language learning environment. Following observations on learner's logs in an informal language learning environment, we conclude that learners tend to have a general vocabulary, i.e., words that are semantically related throughout their vocabulary, as well as a situated vocabulary, i.e., words that are semantically related within a short period of time. Based on those observations, we proposed three methods, that use their past vocabulary to identify their intended meaning. The first method considers that the intended meaning of the learner is the one that is the most semantically similar to the learner's past vocabulary. The second method builds on the first method but gives more weight to the vocabulary that the learner

logged shortly before the target word. The third method addresses situations where the semantic similarities between the different meanings of the word and the past vocabulary have similar values. In those cases, the method considers that the intended meaning of the learner is the most common meaning in the target language. The three methods were evaluated using 148 logs of SCROLL, an informal language learning environment. The success rates of the three methods were respectively 72.18%, 75.63%, and 83.05%. This work shows that the past activity of language learners in informal language learning environments could be used to identify their intended meaning when learning a new word.

Chapter 6

Understanding vocabulary: providing explanations using the learners' past knowledge

6.1 Introduction

6.1.1 Understanding culturally-specific vocabulary

An essential part of the vocabulary learning process is the understanding of the words of the target language. Most of words are easy to understand as they have an equivalent in the learners' native language. However, some words are specific to a certain language or culture, and are non-translatable to the learner's language, e.g.: sumo, sushi, schnitzel. Many of those words are culturally specific, and intercultural competence is viewed as being as important as communication and should be an integral part of the language curriculum [101]. However, the inclusion of the cultural aspect in language teaching has been challenging for teachers [59]. An important aspect of understanding another culture is the knowledge of its related products and artifacts [21]. In an informal learning environment, learners can refer to the definition of the culturally specific vocabulary. But reading the definition of an unknown concept or product often leaves the learner with many question marks.

Today's technologies allow us to extract the learner's previous knowledge based on their culture. We propose to explain the culturally specific vocabulary based on the learner's cultural knowledge.

6.1.2   Case study: food products

Vocabulary related to food products is usually instantly encountered when familiarizing with a foreign culture and highlights cultural differences. Food, eating, food behaviors and food social norms are intimately connected to cultural identity and deeper cultural concepts [55, 96]. One method to explain a particular food product to a learner would be to display a complete listing of the ingredients as well as a description of the food product. However, this kind of information might leave them with questions like: How does it taste like? What is the texture? When do we use it?

6.1.3   Goals of the study

In a situation where providing a simple description of a product fails to deliver a complete understanding of the meaning of the product, an efficient alternative would be to relate the product to a similar product in the learner's culture. This would mean offering Culturally Situated Associations (CSA) that allow learners to understand the meaning, usage, and taste of the food product they are inquiring about. A system that supports learners with CSA must deliver the associations and make sure that those associations are understood. The previous requirements can be fulfilled by learning Culturally Situated Dialogue (CSD) strategies that would support the realization of those objectives. However, when no initial observations or system exist, learning dialogue strategies is a challenging task. In fact, developers or designers of a CSD system may not be able to predict the most appropriate action to be taken by the system at each moment and would have to invest in a time consuming task to predict the most appropriate action in the given situation. Moreover, the number of different utterances that could occur in a dialogue system are numerous and previous work showed that automatic dialogue strategies outperformed handcrafted ones [95]. Ishida highlighted the need "to model agents that can not only support a specific culture, but also recognize the differences among cultures, and differences among the understanding of cultural differences" [49]. Aligning with the need for an agent that can provide CSA and addressing the challenge of automating CSD strategies in the particular situation where no initial system exists, this research proposes a method to learn CSD strategies to support learners when no data or working prototype exists.

6.2   Background

6.2.1   Culture and vocabulary learning

6.2.2   Culturally situated associations

A variety of intercultural communication models have been proposed by researchers. However, the most influential model is attributed to Byram because his approach provides a holistic intercultural competence and has defined objectives and practical derivations [23]. Byram's model defines the five following skills needed in order to accomplish a successful intercultural communication: intercultural attitudes, knowledge, interpreting and relating, discovery and interaction as well as critical cultural awareness [20]. Two of those skills are necessary in the initial stages of familiarizing with a new culture and are essential to understand foreign concepts or products [20]:

- Discovery or knowledge: knowledge about a social group and their products and practices in the foreign visitor's own country; and

- Interpreting and relating: foreign visitors relate the information they get to information from their own culture.

Over the years, efforts have been made to use computer technologies to support the teaching of culture. To understand the other culture, different approaches were implemented: showing to learners juxtaposed texts from different cultures [70], concordances of two corpora to investigate different usages of a word in different cultures [67], use of web-based tools (online forums, weblogs, Skype, and email) [23]. However, most of previous studies focused on fostering Byram's skills of: intercultural attitudes, knowledge, discovery and interaction.

The skills of interpreting and relating are not tackled in computer-assisted education and consists of putting concepts or products from two or more cultures side by side and seeing how each might look from the other perspective [23]. Providing learners with CSA means putting the concepts or products from the learner's culture and from the target culture side by side and helping the learner interpret and relate the concepts that they encounter.

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6.2.3 Dialogue strategies

In real life situations, interpreting and relating cannot be achieved in real time as CSA requires a deep knowledge about the foreign culture and information about the learner's culture. In order to provide learners with CSA that they can understand, we must gather information about their culture, provide them with the CSA and make sure they understand it. In this case, a Culturally Situated Dialogue (CSD) must take place. To carry the dialogue, dialogue systems must follow a dialogue strategy.

The recent literature shows a growing interest in the implementation and use of automatic dialogue systems. The development of such dialogue systems, and more particularly the development of dialogue strategies is challenging [33]. In order to achieve a dialogue in an efficient way through a series of interaction with the user, dialogue strategies are needed. By quantifying the achievement of the dialogue goal as well as the efficiency of the strategy, is it possible to describe the system as a stochastic model that can be used for learning those dialogue strategies [69]. This method has many advantages including a possibility of an automation of the evaluation of the dialogue strategies as well as an automatic design and adaptation. In previous works on dialogue systems, reinforcement learning was used in order to learn wizard of oz' dialogue strategies of presentation of information and replicate them. Wizard of oz allows the learning of dialogue strategies when no initial system exists. The results showed that reinforcement learning combined with wizard of oz experiment allows the development of optimal strategies when no working prototype is available [91]. In fact, reinforcement learning significantly outperformed supervised learning when interacting in simulation as well with as with real users [91]. However, unlike standard dialogue systems that take into account user-related properties, the challenge in learning optimal CSD strategy consist of learning which information about the learner's culture, if any, should be inquired and in which order.

6.3 Wizard of Oz

The wizard of oz (WoZ) is a research experiment in which the users interact with a computer system that they believe to be autonomous. The computer system is actually operated either partially or completely by a human being (the wizard) [57]. The WoZ experiment is useful in different cases. It allows the gathering of information in the case of lack of basic knowledge about the user performance during a computer based interaction.

Moreover, the usage of WoZ will allow many speech designers to participate in building the knowledge about the user performance during a computer based interaction. Finally, the WoZ allows an iterative design approach for building user interfaces as it is easy to use, requires little programming and supports rapid testing and interfaces modifications [61]. The design of a WoZ experiment may contain different amounts of control ranging from a complete automation of the interaction to an interaction solely dependent on the wizard, as well as mixed initiative interactions [90]. Green, Huttenrauch and Eklundh set one of the most recognized conditions for conducting a WoZ experiment: The user should have access to specific instructions, the designers should have a behavior hypothesis as well as a specified robot behavior [40]. The architecture's requirements of a WoZ experiment were set by Fraser and Gilbert that state that: 1. "It must be possible to simulate the future system, given human limitations;" 2. "It must be possible to specify the future system's behavior;" 3. "It must be possible to make the simulation convincing" [37]. The implementation of WoZ experiments should use scenarios to place additional constraints on the study. Previous guidelines highlight the importance of scenario constraints for WoZ experiments. [26, 37, 40, 90]. The scenario constraints allow participants to have a task to solve that requires the use of the system, and where there is not a single way to solve the problem [26, 90]. Finally, in a review paper, Riek (2012) went through 54 papers and categorized the papers by types of wizard control used. 72.2% of the papers reported using the WoZ experiment to control a Natural Language Processing component such as having the robot engage in a dialogue and appropriately make utterances. The use of WoZ has shown to be beneficial to design and test dialogue strategies when no initial data or working prototype exists [91]. Using WoZ is a way of collecting data, before actually building a system that might need this data to be built. Moreover, it allows the testing of parts of the system without having to program and design the whole system in order to do it.

6.4 Overview of the system

Figure 6.1 shows the system architecture. The WoZ experiment is used because no working prototype or initial CSD system is available. The learner and the wizard communicate through Skype to allow the wizard to see the product the learner is asking about. In order to provide the wizard with the optimal dialogue strategy, an agent is trained based on a

reinforcement learning algorithm, and passes to the wizard the optimal strategy to take at each step. The wizard reports first their state of knowledge to the agent through a web interface (e.g.: I don't have any information about the learner's country yet). Once the agent receives the current state of knowledge of the system, it provides the wizard with the appropriate action to take (e.g: Ask for the learner's country). If the agent suggests the querying of the associated concept, the wizard retrieves the CSA from a provided database. The database contains food items as well as their related country of origin, the region of origin, the related ingredients and their usage. The dialogue, directed by the agent, and executed by the wizard is carried out until the CSA is provided to the learner and understood by them.
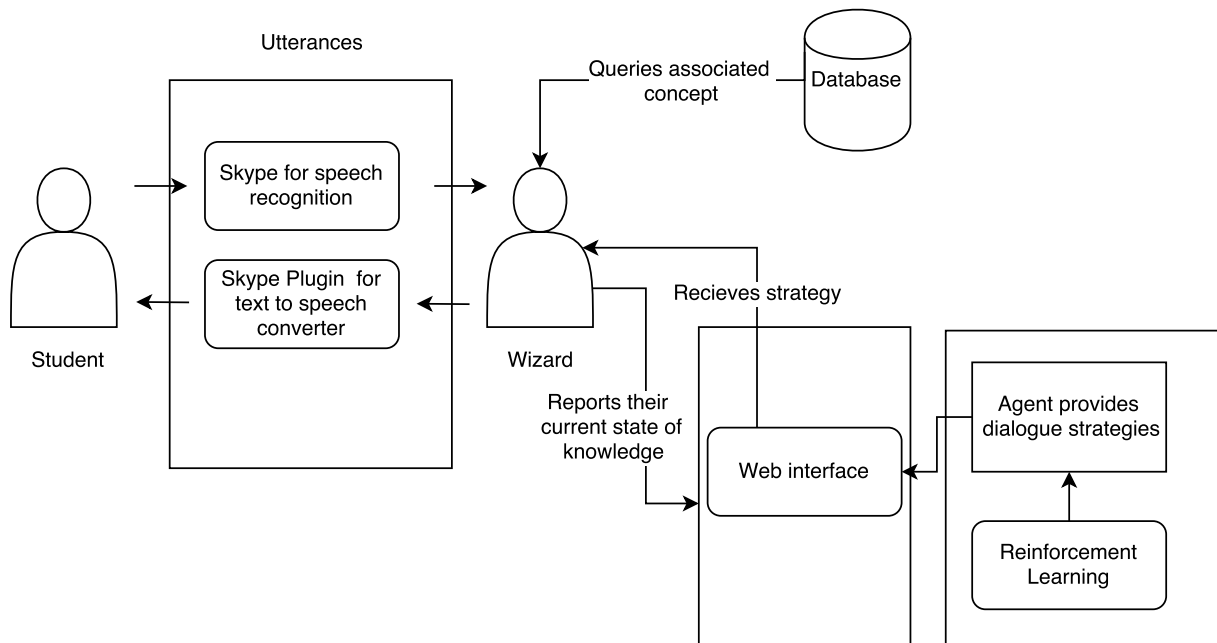
Figure 6.1: System Architecture.

6.5   Identification of dialogue patterns

In order to extract the necessary components needed to build the feature space of the reinforcement learning algorithm and create the automatic dialogue strategies, we first identify common natural dialogue patterns to provide CSA to learners.

To identify the possible dialogue patterns, we first conducted interviews with tourists in Nishiki Market, a traditional food market in Kyoto. We interviewed 15 tourists coming from western countries, chosen randomly during their visit to the market. We decided to

interview tourists instead of learners due to the fact that Japanese language learners might have different levels of familiarity with Japanese products depending on their language level. This difference might lead to dialogue patters that are not representative of the ones a beginner language learner would have. The breakdown of gender was balanced and the participants were from Europe, New Zealand and U.S.A. The tourists were asked to list the questions that they would have wanted to ask if it was possible to communicate with the shop clerks and get an answer. We received 34 questions from the participants. Table 6.1 shows the different questions asked by participants from different countries.

Table 6.1: Categorization of questions asked by tourists by country

Country	Number of participants	Questions asked by the participants
France	2	Is it vegetarian? What is this? (2 instances) How does it taste like?
Germany	1	What is this? What is the difference between udon and soba? How do we eat it?
New Zealand	2	What is this? (2 instances) How do we eat it? Can I take back home through the customs?
Spain	2	What is this? (2 instances) How is it used in cooking? What are the ingredients? How do we eat it?
United Kingdom	3	What is this? (2 instances) How do we eat it? (2 instances) How is it used in cooking? is it vegetarian?
USA	5	Is it vegetarian? (2 instances) What is this? (3 instances) How does it taste like? (2 instances) How do we eat it? (2 instances) How is it used in cooking? What are the ingredients? (2 instances)

Similar questions were put together and the tourists' questions were categorized by question topic. The questions of the tourists were classified into three categories shown in Table 6.2. The first category contains the questions about the ingredients of a particular food. Questions about the taste were classified under the ingredients category as we considered that the ingredients of the food can give an idea about the taste (salty, sweet, sour, etc.). The second category includes the questions about the usage. The last category includes general questions about the composition and the usage of the food.

Table 6.2: Categorization of questions asked by tourists by question topic

Category	Associated Tourists' questions
Ingredients	How does it taste? Is it vegetarian?
Usage	How is it used? How do we eat it?
General questions	What is this? What is the difference between X and Y?

Based on the previous questions provided by the tourists, we create typical dialogues that could happen between the shop owners and the learners during their travels. During those conversations, shop owners naturally follow a CSD strategy to answer the questions of the learners with CSA. We match each of the previous examples to a pattern of CSD. To further understand the CSD, we define several terms as follows:

- *Target concept* is the concept that needs to be explained.

- *Associated concept* is used to explain a target concept. It is a concept that belongs to a different culture than the target concept.

- *Common attribute* is an attribute or a property that belongs to both the target and the associated concepts.

- *Cultural attribute*, such as a location, language, etc., is a common attribute which contributes to determine a culture.

Using the previous terms, we classify culturally situated conversations into several culturally situated dialogue patterns:

Example conversation 1

Student: What is this and how does it taste?

Shop owner: It is Neri Goma. It is a paste made out of roasted sesame seeds. Where are you from?

Student: Iraq.

Shop owner: It is like Tahine.

Dialogue Pattern 1: Using cultural attribute as a pivot

Student: Question about the taste of the target concept.

Shop owner: Question to identify the cultural attributes of the learner.

Student: learner provides the cultural attributes.

Shop owner: Finds the associated concept that possesses cultural attributes that matches the learner cultural attributes and common attributes related to the taste that are identical to the common attributes of the target concept.

Example conversation 2

Student: What is this? How do we use it?

Shop owner: It is Neri Goma. It is a paste made out of roasted sesame seeds. Where are you from?

Student: Iraq.

Shop owner: It is like Tahine, but in Japan it is mainly used in sweets.

Dialogue pattern 2: Comparative association

Student: Question about a target concept.

Shop owner: Question to identify the cultural attributes of the learner.

Student: learner provides the cultural attributes.

Shop owner: Finds the associated concept that possesses cultural attributes that matches the learner cultural attributes and common attributes related to the taste that are identical to the common attributes of the target concept. In case other common attributes differ from the target concept's common attributes, the differences are presented to the learner.

Example conversation 3

Student: What is this?

Shop owner: It is Udon, noodles made out of wheat and flour. They are usually eaten in broth.

Student: What is the difference with Soba?

Shop owner: Udon is made out of wheat and Soba out of buckwheat. Where are you from?

Student: Italy

Shop owner: Udon is more like Spaghetti and Soba like Pizzoccheri

Dialogue Pattern 3: Intra-Cultural Comparison

Student: Question about the difference between two target concepts.

Shop owner: Question to identify the cultural attributes of the learner

Student: Learner provides the cultural attributes.

Shop owner: The difference between the two target concepts is identified by comparing all their common attributes. Based on the cultural attributes of the learner, two associated concepts with the same difference in the common attributes are found.

Based on the previous dialogue patterns, we extract the components essential to conduct CSD strategies:

- Target Concept

- Associated concept

- Cultural Attributes

- Common Attributes

6.6 The Reinforcement Learning Algorithm

The Markov Decision process is a mathematical formalism that is used to implement the reinforcement learning algorithm. Our algorithm was based on Ng's work [81]. The main components of this formalism and their implementation are:

State and action space: The states of the reinforcement learning algorithm amounts to all the states that the system (the wizard in our current system) possesses about internal and external resources that it is interacting with (e.g. country of the learner, associated concepts). The action set of the dialogue system includes all possible actions it can accomplish. It includes the interactions with the user (e.g. asking the learner for their region, providing the learner with an associated concept) as well as the interactions with other resources (e.g.: searching for the associated concepts). When the system's current state is s and an action a is taken, the state changes to s'. For example, when the system is in an initial state and the wizard does not have any information, the agent will ask the wizard to interact with the learner and obtain a specific information. The next state, s', will depend on whether the wizard obtained the information or not.

We identified the possible state spaces based on the components extracted from the dialogue patterns. The target concept is assumed to be known as the wizard would be interacting with the learner and would be able to identify it. The cultural attributes are necessary in order to determine the culture of the learner, and thus, in which culture the associated concepts should be found. learners usually have a question that is related to a particular common attribute (e.g.: usage, ingredients). The common attributes are necessary as they will be the basis of the comparison between the target concept and the associated concept. The action space is directly extracted from the state space. Based on the previously defined components, we created three levels of state spaces with different granularity in terms of states spaces. The three different agents were named respectively: Novice agent, Intermediate agent and Advanced agent.

Transition probabilities: The transition probabilities of transitioning between a state s

to a state s' given an action a are estimated using observed data. The estimated transition probability, $P_{s,a,s'}$, is computed as follows:

$$P_{s,a,s'} = \frac{number\ of\ times\ we\ took\ action\ a\ in\ state\ s\ and\ got\ to\ s'}{number\ of\ times\ we\ took\ action\ a\ in\ state\ s} \quad (6.1)$$

In the case where an action a is never taken from a state s, we consider $P_{s,a,s'}$ to be equal to $\frac{1}{number\ of\ states}$, assuming that the probability is equally distributed over all states.

Reward: We suppose that the reward is unknown. We can also compute the expected immediate reward in a specific state as the average reward observed in state s.

Value iteration and policy: A policy is any function π that maps the states to the actions. Some policy π is executed if, whenever we are in state s, we take the action $a = \pi(s)$. The value function for a policy π is the expected sum of discounted rewards when we start in state s and take actions according to π. The value function of a policy π is given by the Bellman equation [13].

$$V^{\pi}(s) = R(s) + \gamma \sum_{s' \epsilon S} P_{s\pi(s)}(s')V^{\pi}(s') \quad (6.2)$$

The Bellman equation states that the expected sum of discounted rewards $V^{\pi}(s)$ is given by the sum of the immediate reward and the expected sum of future rewards. We define as well the optimal value function given by:

$$V^{*}(s) = maxV^{\pi}(s) \quad (6.3)$$

$V^{*}(s)$ is the best expected sum of discounted rewards that can be reached using any policy. Based on the previous equations, we will describe the algorithm that we used to calculate the value function and to get the best policy:

●For each state s, initialize $V^{\pi}(s) = 0$

●Repeat until convergence: For each state, update:

$$V^{\pi}(s) = R(s) + \gamma \times max(a\epsilon A) \sum_{s' \epsilon S} P_{s\pi(s)}(s')V(s') \quad (6.4)$$

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•Policy in state s is the $a \epsilon A$ which maximizes V(s).

In this algorithm, we are updating the estimated value function based on the Bellman equation. For every state s, we compute the new value of V(s). After a certain number of iterations, the value is supposed to converge towards V*(s).

6.6.1 The novice agent

The first level feature space produces the Novice Agent. The state space includes only three entries that represent the mental state of the system, in other terms, the current state of the wizard.

- Doesn't Know the user's culture/Knows the user's culture.

- Doesn't know the associated concept/Knows the associated concept.

- Knows that the user doesn't understand the concept/Knows that the user understands the concept.

Every entry can take either of its values, giving us a total number of eight states, including two final states. The final states are the states we want the agent to reach at the end of the dialogue. An episode of the reinforcement learning algorithm ends when the final states are reached. At the end of the dialogue the learner should get an associated concept that answers their question and they should be able to understand the associated concept provided to them. The final states are all the combination of states that include the two following entries: Knows the associated concept; Knows that the user understands the concept:

- Knows the user culture/Knows the associated concept/Knows that the user understands the concept.

  and

- Knows the associated concept/ Knows that the user understands the concept.

For the first level feature space, the action space includes only three actions:

- Identify the user's culture.

- Identify the associated concept.

- Ask if the user understood the concept.

6.6.2 The intermediate agent

The second level state action space produces the Intermediate agent. The second level state space is the result of breaking down the first level state space into more precise states of knowledge. It includes six entries that represent the mental state of the system.

- Doesn't know the user's country/Knows the user's country.

- Doesn't know the user's region/Knows the user's region.

- Doesn't know the common attributes/Knows the common attributes.

- Doesn't know if there is an associated international concept/Knows that there is an associated international concept/ Knows that there is not an associated international concept.

- Doesn't know the cultural associated concept/ Knows the cultural associated concept.

- Doesn't know if the learner understood the associated concept/ Knows that the learner understood the associated concept/ Knows that the learner didn't understand the associated concept.

Every entry can take either of its values, with all permutations giving us a total number of 144 states, including 15 final states. To be in a final state, the agent should know the associated concept and should know that the user understood the associated concept. Moreover, the knowledge of the system should be consistent (E.g: The system knows the cultural associated concept but doesn't know either of the cultural attributes, is not a final state).

For the second level state space, the action set includes six actions:

- Identify the user's country.

- Identify the user's region.

- Identify the common attributes.

- Identify if there is an associated international concept.

- Identify if there is a cultural associated concept.

- Ask if the user understood the concept

6.6.3 The advanced agent

The third level state action space produces the Advanced agent. The third level state space is the result of breaking down the second level state space in more precise states of knowledge. It includes seven entries that represent the mental state of the system:

- Doesn't know the user's country/Knows the user's country.

- Doesn't know the user's region/Knows the user's region.

- Doesn't know the common attributes/Knows the common attributes.

- Doesn't know if there is an associated international concept/Knows that there is an associated international concept/ Knows that there is not an associated international concept.

- Doesn't know the country associated concept/ Knows the country associated concept.

- Doesn't know the region associated concept/ Knows the region associated concept.

- Doesn't know if the learner understood the associated concept/ Knows that the learner understood the associated concept/ Knows that the learner didn't understand the associated concept.

Every entry can take either of its values, with all permutations giving us a total number of 288 states, including 17 final states. To be in a final state, the agent should know the associated concept and should know that the user understood the associated concept. Moreover, the knowledge of the system should be consistent (E.g: The system knows the cultural associated concept but doesn't know either of the cultural attributes is not a final state). For the third level state space, the action set include seven actions:

- Identify the user's country.

- Identify the user's region.

- Identify the common attributes.

- Identify if there is an associated international concept.

- Identify if there is a country associated concept.

- Identify if there is a region associated concept.

- Ask if the user understood the concept.

6.6.4 Observations

In order to obtain a policy, we create three sets of observations. Three set of observations are created for the three agents: Novice, Intermediate and Advanced. The three created sets contain 1000 observations each. The observations are designed to simulate the ones that would be noted by a wizard. During this work the minimal number of observations was calculated taking into consideration the case where every state is visited by every action. In order for the simulation to be representative, the observations conform to the following assumptions:

- The wizard cannot find the country's associated concept or region's associated concept if the user's country or region is not identified. As the associated concept is queried based on the learner's cultural attributes, it will be impossible to find it in the case where this information is not provided.

- The wizard cannot find the associated concept if the common attributes that the learner is asking about are not identified. In fact, the comparison between a target concept and an associated concept is queried based on the property the learner is asking about. If the learner is asking about the usage, the associated concept will be a concept in the learner's culture that has the same usage.

- If wizards are searching for international associated concept they will find it around 20% of the times. We consider that it is infrequent for a concept to have an equivalent concept known internationally.

- If wizards present an associated international concept to the learner, the learner will understand it around 80% of the times. We consider that if a concept has an equivalent concept known internationally, the learner will probably know it. This assumption was made based on the Pareto principle [80].

The Novice agent needs a little amount of observations to cover all the actions that could be taken from every state (24 observations). The Intermediate agent needs a more observations than the Novice agent to cover all the actions that could be taken from every state (864 observations). The Advanced agent needs the biggest number of observations to cover all the actions that could be taken from every state (2016 observations). Figure 6.2 plots the minimum number of observations versus the number of states.
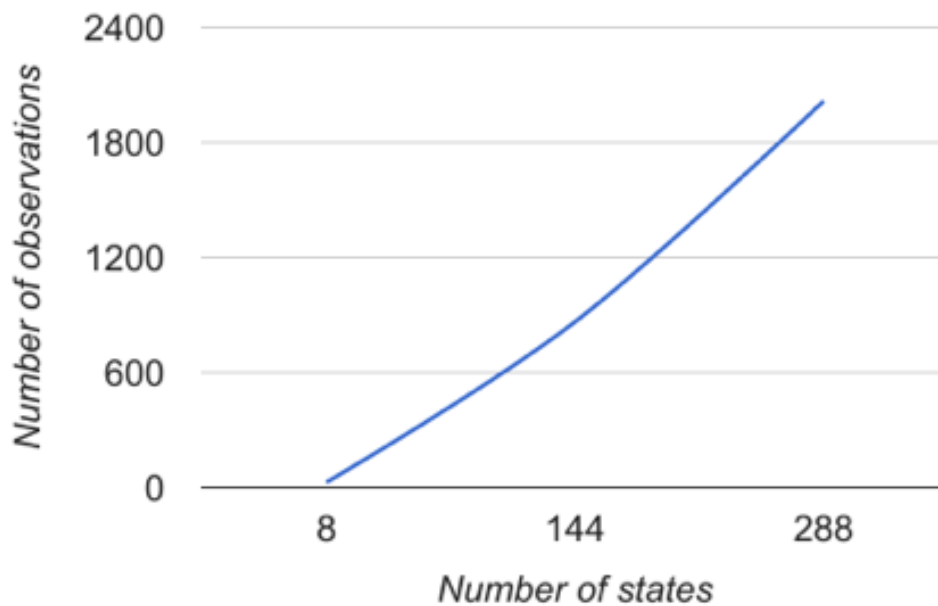

Figure 6.2: Minimum number of observations needed versus the number of states.

6.7   Strategy evaluation

In order to evaluate the quality of the conversation strategy we assume that the wizard follows the recommendations of the agent except when:

- The agent is asking the wizard to take the same action twice or more and the wizard

knows that the action will not change the current state of knowledge and will keep the dialogue in the same state.

- The agent is asking the wizard to present an information to the learner while the information is unavailable.

We define a score representing the quality of the policy by:

$$Score = \frac{n}{N} \tag{6.5}$$

With n the average number of times the wizard followed the agent's recommendations per dialogue and N the average of recommendations received per dialogue. The score of the quality of the policy varies between 0 and 1.

The experiment

In order to evaluate the different policies, we prototyped a wizard of oz experiment set as follows:

The participants The experiment involved two participants:

- 1 wizard: PhD student in informatics, in Japan (27 years old).

- 1 student: Female Italian language student that arrived to Japan two weeks before the experiment to learn Japanese (26 years old).

The learner's role was to ask about a concept she did not understand. The wizard's role was to provide CSA to the learner. The two participants didn't know each other previously. We will call the first participant *wizard* and the second participant *learner*. The only prerequisite to participate in the experiment targeted the user of the system that had to be a Japanese language learner that moved recently to Japan. We met both participants separately and provided them with the objectives and the rules of the experiment.

We met with the student before the experiment and gave her a list of food products. We explained that she had to choose an item she didn't know, then ask for explanations about it through the system. We showed the student the system and explained how the interaction with the system will take place. We also explained to the student that the

system will help her understand the target concept and that she was interacting with a human being through the system. We also met with the wizard before the experiment and specified the behavior to be adopted during the experiment. The wizard received a training to become familiar with the objective of the dialogue, the actions that can be taken, and the database. We explained to the wizard that the dialogue strategy recommended by the system should be followed. We also provided the wizard with the two situations in which the systems' recommendation can be ignored: 1- the system is asking the wizard to take the same action twice or more and the wizard knows that the action will not change the current state of knowledge and will keep the dialogue in the same state; 2- the agent is asking the wizard to present an information to the student while the information is unavailable.

The setting of the experiment

- The wizard and the student were interacting via two computers using Skype. The wizard was typing and the student was hearing the answer through clownfish plugin that converts text to speech.

- The wizard had access to a simple database representation from which the CSA could be extracted based on the cultural attributes and common attributes.

- The wizard and the student were asked to perform the dialogue three times. The first time, the Novice agent's strategy was suggested to the wizard. The second time the Intermediate Agent's strategy suggested was communicated to the wizard. The third time the wizard was provided with the Advanced Agent's strategy.

Results of the experiment   While receiving the Novice Agent's strategy, the wizard followed the recommendation of the agent four times over six times as shown in Table 6.3. The Wizard reported that the recommendations of the agent were too abstract. They also reported that when the action suggested was to find the associated concept, the wizard found two associated concept belonging to the same country. It was hard for them to present one to the learner as there was no appropriate guidance for this situation.

While receiving the Intermediate Agent's strategy, the wizard followed the recommendation of the agent six times over seven times as shown in table 6.4. The wizard reported that the recommendations of the agent were helpful to guide them through the process.

Table 6.3: Dialogue between the wizard and the Novice agent and wizard's compliance to recommendations (Green: compliance, red: non compliance)

Compliance to agent's recommendation	Learner's utterance	Agent's recommendation	Wizard's action
Yes	"What's this?" (asking about udon)	Identify the user's culture	Wizard asks the learner: "What is your culture?"
Yes	"I am Italian"	Identify the associated concept	Wizard looks at the database representation and finds two corresponding items: Pici and Stringozzi
Yes		Tell the user the associated concept and ask them if they understood it	Wizard tells the learner: "It is like Pici. Do you know Pici?"
No	"No, I don't"	Tell the user the associated concept and ask them if they understood it	Wizard took their own initiative and asks the learner: "Where in Italy are you from?"
No	"Tuscany"	Tell the user the associated concept and ask them if they understood it	Wizard took their own initiative and looked in the database representation for an associated concept from Tuscany
Yes		Tell the user the associated concept and ask them if they understood it	Wizard asks the learner: "It is like Stringozzi. Do you know Stringozzi?"
	"Yes, Thank you."		

They reported confusion when the learner didn't understand the first associated concept, and the recommended action didn't change. The wizard had to take actions that are different from the agent's recommendations.

While receiving the Advanced Agent's strategy, the wizard followed the recommendation of the agent eight times over eight times as shown in table 6.5. The Wizard reported that the recommendations of the agent were helpful and precise enough to guide them through the process. They reported that the process was conducted without any confusion.

Figure 6.3 shows the score of the quality of the policy by the number of states. For the Novice Agent the quality of the policy is equivalent to 0.66 and is poor compared to the Intermediate Agent (0.875) and the Advanced Agent (1).
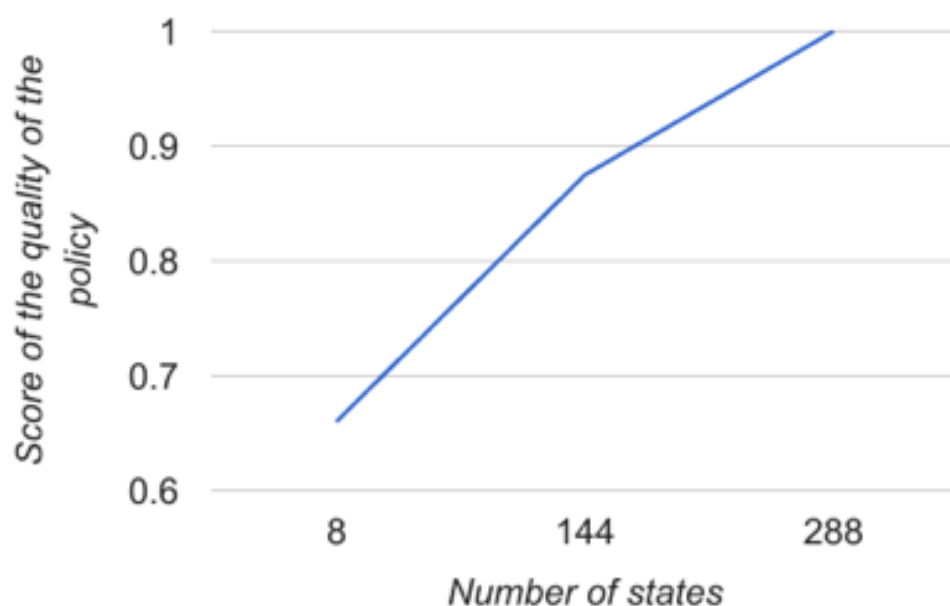

Figure 6.3: Score of the quality of the policy by number of states.

Table 6.6 shows the summary of the evaluation as well as the recommendation as of the usage of each agent.

Table 6.4: Dialogue between the wizard and the Intermediate agent and wizard's compliance to recommendations (Green: compliance, red: non compliance)

Compliance to agent's recommendation	learner's utterance	Agent's recommendation	Wizard's action
Yes	"What's this?" (asking about udon)	Identify the user's country	Wizard asks the learner: "Where are you from?"
Yes	"Italy"	Identify the user's region	Wizard asks the learner: "Which region in Italy?"
Yes	"Tuscany"	Identify the common attributes the user wants to know about	Wizard asks the learner: "Do you want to know about the ingredients, the usage, or both?"
Yes	"Both please"	Identify the associated concept	Wizard looks at the database representation and searches for an associated concept based on the country and the common attributes. They find two corresponding items: Pici and Stringozzi
Yes		Tell the user the associated concept and ask them if they understood it	Wizard tells the learner: "It is like Pici. Do you know Pici?"
No	"No, I don't"	Tell the user the associated concept and ask them if they understood it	Wizard took their own initiative and looked in the database representation for an associated concept based on the region and not the country. They find Stringozzi.
Yes		Tell the user the associated concept and ask them if they understood it	Wizard asks the learner: "It is like Stringozzi. Do you know Stringozzi?"
	"Yes, Thank you."		

Table 6.5: Dialogue between the wizard and the Intermediate agent and wizard's compliance to recommendations (Green: compliance, red: non compliance)

Compliance to agent's recommendation	Learner's utterance	Agent's recommendation	Wizard's action
Yes	"What's this?" (asking about udon)	Identify the common attributes the user wants to know about	Wizard asks the learner: "Do you want to know about the ingredients, the usage, or both?"
Yes	"Both please"	Identify the user's country	Wizard asks the learner: "Where are you from?"
Yes	"Italy"	Identify the associated concept based on the country	Wizard looks at the database representation and searches for an associated concept based on the country and the common attributes. They find two corresponding items: Pici and Stringozzi.
Yes		Tell the user the associated concept and ask them if they understood it	Wizard tells the learner: "It is like Pici. Do you know Pici?"
Yes	"No, I don't"	Identify the user's region	Wizard asks the learner: "Which region in Italy do you come from?"
Yes	"Tuscany"	Identify the associated concept based on the region	Wizard looks at the database representation and searches for an associated concept based on the region and the common attributes. They find one corresponding item: Stringozzi.
Yes		Tell the user the associated concept and ask them if they understood it	Wizard asks the learner: "It is like Stringozzi. Do you know Stringozzi?"
	"Yes, Thank you."		

Table 6.6: Summary and recommendations

	Novice Agent (8 states)	Intermediate Agent (144 states)	Advanced Agent (288 states)
Score of quality of policy	0.66	0.875	1
Number of observations needed to obtain the policy	24	864	2016
Recommendation	Use this policy for number of observations varying between 24 and 863	Use this policy for number of observations varying between 864 and 2016	Use this policy for number of observations bigger than 2016

6.8   Discussion

There is a need for developing and designing language tools that support a more complex view of language that the traditional formal approach and allow the users to explore meaning related aspects of the target language. It is suggested that a user-centered and iterative design process would be a good starting point to design the language tools [62]. We proposed a tool that aims to support learner understanding foreign concepts and building intercultural competence. The interviews conducted led to the creation of a user-centered system.

We propose to use CSA to understand foreign concepts. CSA are based on Byram's model that is a widely accepted model that defines intercultural competence, and more particularly on the skill of interpreting and relating. Byram's model proposes five skills needed to accomplish intercultural communication: (1) intercultural attitudes, (2) knowledge, (3) interpreting and relating, (4) discovery and interaction as well as (5) critical cultural awareness [20]. Many studies used computer-mediated communication to develop second language learners' intercultural competence based on the Byram's model. However, most of past research focused on systems that help with developing the skills of intercultural attitudes, knowledge, and discovery and interaction [70]. This study, unlike previous studies, aimed at using computer supported communication to develop the skill of interpreting a concept from another culture and relate it to concepts from one's own.

The method proposed in this research allows the creation of automatic CSD strategies

to support foreign learners during their food shopping in Japan. The method could be potentially generalized to learn automatic dialogue strategies in any situation where CSA may be needed and when when little initial data or system exists. Technical and non-technical limitations of the system are highlighted and discussed below:

Range of application

The proposed system supports learners with the understanding of foreign concepts. This system focuses on culturally specific concepts expressed through words (e.g.: udon, tahine, Kimono, paella, etc.). However, this system does not support learners with the understanding of culturally specific sentences such as idioms or proverbs. Future application of the proposed method to support the understanding of culturally specific sentences might lead to interesting results.

Dialogue Patterns

The number of collected dialogue patterns was based on interviews conducted in Nishiki Market. Our state spaces were derived from the dialogue patterns. However, the number of dialogue patterns may not cover extensively all the culturally situated scenarios that could happen. A more extensive survey should be conducted to cover a vast majority of the questions that might be asked and thus allow the potential identification of more dialogue patterns.

State Spaces

In this work, we chose three state spaces as a base for our learning algorithm. As a result, three agents could provide the wizard with dialogue strategies varying from an abstract strategy to a precise one. The extraction of state spaces was a result of the breaking down of the attributes derived from the dialogue patterns. However, the attributes could be broken down more elaborate strategies. This work explores only three state spaces and their resulting strategies. However, by breaking down more the attributes we would be able to study more developed agents.

Minimal of observations needed

The observations fed to the learning algorithm are one of the main components defining the resulting strategy. During this work the number of minimal number of observations

was calculated taking into consideration the case where every state is visited by every action. However, the minimal number of observations needed in order to produce an effective strategy depends on the actions and the states visited.

The experiment

The experiment objective was to compare the three different agents' performances for the same request done by the learner. As the objective is the comparison of the dialogues, one pair of learner-wizard might be adequate. In the experiment, the dialogue initiated by the learner was chosen based on the most asked question by the tourists in the interviews (what is this?). However, it would be beneficial to broaden the range of dialogues in order to compare the different agents in different real-life situations. This could be explored later on in a study about the system itself.

6.9   Conclusion

In this research, we propose a method to learn culturally situated dialogue strategies to support foreign learners, using a reinforcement learning algorithm. Since no previous system was implemented, the method allows the creation of dialogue strategies when no initial data or prototype exists. To model the possible state spaces of the reinforcement learning algorithm, we first identified common dialogue patterns that take place between learners and shop owners in Nishiki Market and extracted the attributes needed to conduct Culturally Situated Dialogues. By breaking down the extracted attributes into more fine grained attributes we created three attribute sets with different levels of granularity. Each of these three attribute sets was mapped into a different state space, resulting in the creation of three different agents: The Novice Agent, the Intermediate agent and the Advanced Agent. Each of these agents learns a different dialogue strategy. We conducted a Wizard of Oz experiment during which, the Agent's role was to support the wizard in their dialogue with learners by providing them with the appropriate action to take at each step. The resulting dialogue strategies were evaluated based on two criteria: the quality of the strategy and the minimum number of observations needed to result in an acceptable dialogue strategy. The quality of the dialogue strategy was defined to reflect the 'helpfulness' of the agent in supporting the wizard. The Novice Agent was the least effective in producing helpful dialogue strategies for the wizard, however it could learn the

strategy based on only 24 observations. The Intermediate Agent performed better than the Novice Agent but needed at least 864 observations to learn a consistent strategy. The Advanced Agent was able to guide the wizard in all the steps effectively until achieving the objective of the dialogue, and needed a minimum of 2016 observations to produce a consistent strategy. The results suggest the use of the Novice Agent at the first stages of prototyping the dialogue system. The Intermediate Agent and the Advanced Agent could be used at later stages of the system's implementation. Future work could explore the possibilities of automating the process of migrating to more complex agents depending on the available number of observations at each moment. This would allow the application of this technology to a variety of situations where culturally situated information is needed and no initial system or little observations exist.

Chapter 7

Discussion

In this work, we proposed methods to support learner-centered informal vocabulary learning. The proposed methods took advantage of the available data resulting from the widespread usage of technologies for informal language learning.

7.1 Vision behind this work

Currently, informal language learning tools allow learners to learn anytime and anywhere. Language learners use various applications to support their vocabulary learning. To learn new vocabulary, learners use applications such as Memrise and Duolinguo (among the most downloaded applications). To translate words, the most common used tool is Google Translate [31]. To understand culturally-specific concepts, learners might use dictionaries, or even images [87]. However, Duolinguo and other popular applications recommend to the learner vocabulary that they might never need in their personal lives. Google Translate provides translation that might not correspond to the intended meaning of the learner. A dictionary might leave the learner with the inability to fully understand the culturally specific word. Those tools do not adapt to the learner because they don't completely know the learner. For example, while Duolinguo only knows the retention rate of the learner, Google Translate only knows the vocabulary needed by the learner, and Wikipedia the culturally-specific items the learner is interested in.

The vision behind this work is one that provides a highly individualized vocabulary learning. One that would teach the learner the vocabulary that they need based on who they are and what they experience. The centralization of informal vocabulary learning activities would allow a recommendation of words that fits the individual, a disambiguation of the intended meaning of the learner, and the mapping of culturally-specific words

to concepts that the learner already understands. In this way, informal language learning technologies would play the role of a private teacher that knows the learner, her needs, her background, her activities and is able to provide her with the most efficient vocabulary instruction. This vision adapts to a world in movement, where language learning might not necessarily involve the learning of the whole vocabulary of a language, but learning some vocabulary from different languages depending on what ought to be communicated in each one of them.

7.2   Application in formal learning settings

Even though this work targets language learning in informal learning environments, parts of it could be used in a formal learning setting.

In a multicultural environment a language teacher could have difficulties explaining culturally-specific concepts to language learners. The teacher might not possess the knowledge about the concepts and artifacts present in the student's culture. The usage of culturally situated associations proposed in Chapter 6 could allow the students to understand the target concept based on their own culture [4, 58].

Moreover, the proposed methods could be applied to provide the teacher with information on the vocabulary needs of their students. The teacher could then provide the learners with lists of vocabulary based on their personal interests and activities. When students are interested in the material they are learning, they make better connections between different topics, and can recall information better [7, 63].

7.3   Detection of situated roles

While using technologies, users interact with the system in ways that were not intended by the designers [46] which leads to the system playing different situated roles. It would be useful to detect what are the situated roles of the informal vocabulary learning environment for individual users in order to adapt the system by inserting the positive situated roles. However, with the increase of possible features that could be implemented to support informal vocabulary learning, it is important to prioritize the features that would be available to different users based on their individual priorities [45].

7.4 Limitations

Each method in this work was tested on a different group of learners. This may compromise the synergy between the three different methods. Future work could evaluate the learner-centered informal learning environment as a whole as well as the interactions of the learner with the different parts of the system.

On another note, the proposed methods extensively rely on the learners' data and might create privacy concerns. Privacy concerns and uncertainties can negatively affect the usage of a system [112]. To maintain the trust of the user, the system has to maintain transparency and the user has to be aware of the methods used within the system, and give consent to use their past activity for a personalized vocabulary learning experience [2].

Finally, some may argue that a highly personalized vocabulary recommendation and meaning disambiguation could lessen the exposure to other cultures or different worlds. This could be acceptable if the goal of the learner is to achieve a very specific goal using the language. However, some language learners are interested in language learning as an activity, and a highly personalized vocabulary instruction could limit their discoveries. It is important to be aware of the purpose of the learner to be able to optimize their personalization levels.

Chapter 8

Conclusion

To conclude, we will first present the contribution of this research and end by proposing directions for future research.

8.1 Contributions

In this research we proposed information system design methods to support learner-centered informal vocabulary based on the learner's past learning activity and knowledge. This research lies at the intersection of informatics, language learning and design research. In chapter 2, we described traditional approaches to vocabulary learning and highlighted the need for methods that support informal learner centered vocabulary learning. Accordingly, Chapters 3-6 contributed in providing methods to support learner-centered informal vocabulary learning. This work can inform the design of an informal language learning system that supports learner-centered vocabulary learning.

8.1.1 Different language learners, different needs

Chapter 3 investigated a method to identify the learner's needs based on participatory design workshops. The method focused on identifying the learners' tacit needs and latent vocabulary learning needs. We demonstrated that different language learners have different language learning needs, and extracted the needs of Syrian refugees in different stages of their migration journey. This method can be applied as a preliminary step to design informal vocabulary leaning systems and support designers in their understanding of learners' needs.

8.1.2 Vocabulary recommendation based on different vocabulary learning needs

In Chapter 4, we provided a method to personalize the vocabulary recommendation of learners based on their different vocabulary needs. We tested this method on two groups of refugees that are in different stages of migration, and have different motivations to learn the target language. The method was able to provide vocabulary recommendation that increases the retention rate and the motivation to learn the language. This method could be used by designers to build learner-centered informal vocabulary learning tools and provide the language learners with the vocabulary that they might need in the future.

8.1.3 Identification of the intended meaning of the learner based on their learning activities

In Chapter 5, we proposed a method to identify the intended meaning of a language learner when they look up a polysemous word in an informal vocabulary learning environment based on their past activity. We tested this method on existing learner logs and showed the success of the method in identifying the intended meaning of the learner. This method can be applied by language learning tools and online dictionaries designers to disambiguate the intended meaning of the learner and provide them with the appropriate translation based on their individual activities and interests.

8.1.4 Explaining culturally-specific concepts based on their learner's past knowledge

In Chapter 6, we proposed a method that provide culturally situated associations to help learners understand culturally-specific vocabulary. This method uses the past cultural knowledge of the learner and maps the target concept to a similar concept in the learner's own culture. This method can be used to design language learning tools that support language learners based on their initial knowledge.

8.2 Future directions

Future research could build on this research in various ways to improve and optimize informal vocabulary learning.

8.2.1 Vocabulary learner modeling

To be able to design a learner-centered vocabulary tool, we should understand which learner characteristics are important to build learner-centered tools. Currently, learner models are inspired by formal learning situations and the learners models include cognitive characteristics. However, vocabulary learning is personal because the content learned highly depends on the lifestyle, the needs and the aspirations of the learners. For those reasons, future research should aim at building learner models to support informal vocabulary learners.

8.2.2 Automation of learners' characteristics detection

Currently, learner characteristics that are considered when building a language learning tool are extracted from education theory or cognitive science. However, with the uprise of technology use for language learning, we could automatically identify which characteristics impact the language learning, be it individual characteristics, or situational ones.

8.2.3 Centralized learner-centered informal vocabulary learning tool

In this work, different methods are applied to support the language learners during different vocabulary learning activities: vocabulary selection, vocabulary translation, vocabulary comprehension. Future work could assemble those methods into one tool to study its effects on vocabulary learning.

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